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VOL. CXXXVIII.—No. 3596] LONDON: FRIDAY EVENING, NOVEMBER 28, 1924 [PRICE ONE SHILLING

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 19, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—
2074 RAILWAY WAGONS.
Tenders are being called for simultaneously in India. Tenders due on the 15th January, 1925. Tender forms obtainable from above. 7645

Assistant Engineer Required by the GOVERNMENT of NIGERIA for service on the Port Harcourt Harbour Works, which are being carried out departmentally by native labour, for a tour of not less than 12 nor more than 18 months' service. Salary £750, rising to £920 a year by annual increments of £40, plus a cost-of-living allowance of £72 a year whilst on duty in the Colony. Free quarters and passages and liberal leave on full salary. Candidates, aged 30-45, must be duly qualified engineers and have had experience on an engineer's or contractor's staff in the actual construction of reinforced concrete and screw pile steel structures.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/13,230. 7659

Section Engineers (6) Required for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS for four years' service, with possible extension. Salary 400 dollars a month, rising to 475 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent., which is liable to cancellation or revision, plus a consolidated field allowance of 50 dollars a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of six months' salary may be allowed, provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 30 to 38 and unmarried, must be fully qualified railway engineers who have received good training and experience on recognised European, American or Colonial railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, whether married or single, and particulars of qualifications and experience to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting at top of application M/13,264. 7657

Bombay, Baroda, and Central India Railway Company.
The Directors are prepared to receive up to Noon on Wednesday, 10th December, TENDERS for the SUPPLY of :—
(1) STEEL MATERIAL ;
and up to Noon on Wednesday, 17th December, TENDERS for :—
(2) COVERED GOODS WAGONS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. C. S. YOUNG,
Secretary.
Offices : 91, Petty France, Westminster, S.W. 1.
24th November, 1924. 7634

County Borough of Wigan.
SEWAGE DISPOSAL COMMITTEE.
CONTRACT No. 3.
The Corporation invite TENDERS for the PROVISION and INSTALLATION of THREE SETS of ELECTRICALLY DRIVEN PUMPS at the Pemberton Sewage Works.
Plans, specification, conditions and form of Tender may be obtained on application to Mr. R. B. Donald, M. Inst. C.E., Borough Engineer, Municipal Buildings, Library-street, Wigan, on or after Friday, the 28th instant, on receipt of a deposit of £3 3s., made payable to the Corporation, which deposit will be returned to each person or firm submitting a bona fide Tender and returning the plan, specification and conditions.
Sealed Tenders, on the prescribed form of Tender, to be sent to me in the endorsed envelope supplied for the purpose, not later than 10 a.m. on the 16th December, 1924.
The Corporation do not bind themselves to accept the lowest or any Tender, and persons tendering do so at their own cost.
WILLIAM HENRY TYRER,
Town Clerk.
Town Clerk's Office,
Municipal Buildings,
Library-street, Wigan.
24th November, 1924. 7615

Hayfield Rural District Council.
MELLOR WATERWORKS.
The Hayfield Rural District Council invite TENDERS from Contractors for PROVIDING and LAYING about 7½ MILES of 6in., 5in., 4in., and 3in. CAST IRON PIPES, with all necessary VALVES, HYDRANTS and APPARATUS, and also for CONSTRUCTING TWO MASS CONCRETE TANKS at Hayfield and Mellor respectively.
The drawings and specification may be seen at the office of the Surveyor to the Council at Hayfield, Derbyshire, by previous appointment, or at the offices of the Engineers, Messrs. C. and F. W. Hodson, M. Inst. C.E., M. Cons. E., Bank Chambers, Loughborough, from whom copies of the schedule of quantities may be obtained on deposit of cheque for 55s., which will be refunded to contractors making a bona fide Tender on the return of the documents to the Engineers.
Sealed Tenders, on the form supplied, endorsed "Tender for Mellor Waterworks," are to be sent to the undersigned not later than Monday, the 15th day of December, 1924.
The Council do not bind themselves to accept the lowest or any Tender.
J. R. BOWDEN,
Clerk to the Council.
Council Offices,
High-street, New Mills, via Stockport.
17th November, 1924. 7560

The Broadstairs and St. Peter's URBAN DISTRICT COUNCIL. WATER-WORKS DEPARTMENT, have FOR DISPOSAL the undermentioned STEAM PUMPING PLANT, which is being removed from their Bumbelds Pumping Station, viz.:—
A Compound Condensing Deep-well Pumping Engine; Two Triple-expansion Worthington Pumping Engines; a Lono. Type Semi-portable Boiler, by Huston and Proctor; a Lancashire Boiler, by Davey, Paxman and Co.; Deep-well Pumps and Rising Main and other Incidental Plant and Fittings.
Offers are invited for the whole or any complete part of the plant.—Apply, Mr. H. HURD, Waterworks Engineer, Pierremont Hall, Broadstairs. 7629

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Research Laboratory at a Cable Works.
Locomotive Cylinder Performance—No. II.
Marine Oil Engine Trials.
Higher Steam Pressures and Temperatures.
100 Years of British Railways—No. XXII.
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New Italian Warships.
Wire-Drawing and Wire-Working Machinery (No. XVII.).
Materials for High Temperatures.

PUBLIC NOTICES

Government of British Guiana.
CITY OF GEORGETOWN MAIN DRAINAGE, 1924.
SEWAGE PUMPING MACHINERY.
TENDERS are INVITED by Messrs. J. L. Wild and Company, Limited, of 199, Piccadilly, W. 1, for the SUPPLY and DELIVERY, f.o.b., of the necessary ELECTRIC GENERATING PLANT, Direct Coupled to Crude Oil Engines (adapted for Alcohol Burning). Complete with Switchgear, Overhead Transmission Lines and Fifty Vertical Type Electric Motors and Pumps, the latter to be suitable for Pumping Unscreened Crude Sewage.
Drawings and specifications may be inspected by intending contractors at the offices of Messrs. Howard Humphreys and Sons, Consulting Engineers to the Government, at 28, Victoria-street, Westminster, between the hours of 10 a.m. and 4 p.m. (except Saturdays), from Thursday, December 4th, to Tuesday, December 16th, 1924, inclusive.
Intending contractors will be required to deposit the sum of Ten Guineas prior to their being supplied with particulars. This deposit will be returned upon receipt of a bona fide Tender.
Messrs. J. L. Wild and Company, Limited, do not bind themselves to accept the lowest or any Tender.
Tenders and lay-out drawings will be required to be deposited with Messrs. J. L. WILD and COMPANY, Limited, by the final post on January 17th, 1925, and should be marked "Sewage Pumping Machinery." 7617

His Exalted Highness the NIZAM'S GUARANTEED STATE RAILWAYS COMPANY, LIMITED.
THREE JUNIOR ASSISTANT ENGINEERS.
The Directors are prepared to receive APPLICATIONS (by letter only) from duly qualified candidates for APPOINTMENT to the above POSTS in India.
QUALIFICATIONS.—Candidates must have had a good general and technical education and have obtained a degree at a recognised Engineering College or passed the Associate Membership Examination of the Institution of Civil Engineers. In addition it is desirable that they should have had at least one year's practical experience with a railway company or on public works.
SALARY.—Rs. 400-50-1000 per calendar month; commencing salary Rs. 400 to Rs. 500, according to age and experience.
TERMS.—A three years' agreement in the first instance, first-class free passage to India, and home again on satisfactory termination of service. Privilege leave and furlough in accordance with the rules in force.
Applicants must send in to the undernamed a record of their career in chronological order (with dates) and COPIES ONLY of testimonials, service certificates, &c., giving name of firm where pupilage was served and of subsequent employers, with short details of work in each case, and with particulars of general and technical education, honours, &c., gained, not later than the 13th December, 1924.
F. ADAMS,
Secretary.
Offices of the Company :
50, Old Broad-street, London, E.C. 2,
25th November, 1924. 7625

The South Metropolitan Gas Company has a VACANCY for an ENGINEER, with wide experience in the Design, Construction, Erection and Repair of Gasholders, Retort and other Manufacturing Plant and Structures of the kind used in Gasworks and Coke Oven Recovery.
Application, giving age, full particulars of qualifications, experience, military service, and salary required, should be made in writing to the undersigned before 6th December, 1924.
By Order,
FRANK DAY,
Secretary.
709, Old Kent-road,
London, S.E. 15 7614

PUBLIC NOTICES

East Indian Railway.
BRIDGE ENGINEER.
The Directors are prepared to receive APPLICATIONS from properly qualified candidates for APPOINTMENT as BRIDGE ENGINEER in the service of the Company in India.
AGE should not be more than 30 years.
QUALIFICATIONS : Applicants must be proficient in the Design and Manufacture of High-class Bridgework, and some experience in the Erection of such work is desirable. Candidates must have received a good general and technical education, and preference will be given to one who has passed the A.M. Inst. C.E., or possesses a good degree from a recognised Engineering College or University.
SALARY : From Rupees 525 to Rs. 1000 per calendar month, according to age, qualifications and experience, rising in accordance with the Company's rules.
TERMS : A four years' agreement in the first instance, first-class free passage to India.
The selected candidate will only be appointed subject to passing a strict medical examination by the Company's Consulting Physician.
Applicants must state whether they are married or single, and give a detailed record of their career in chronological order, with dates, giving particulars of education, honours, &c., gained, and names of firms where apprenticeship was served and subsequent experience with dates of work in each case. References must be made to the qualifications set out above.
Applications (by letter only) should be addressed to the undersigned, together with COPIES ONLY of testimonials, &c., not later than the 6th December, 1924.
By Order,
G. E. LILLIE,
Secretary.
73-76, King William-street,
London, E.C. 4.
21st November, 1924. 7602

Portsmouth Water Company.
ENGINEERING ASSISTANT.
PERMANENT ENGINEERING ASSISTANT, about 25 to 30 years of age, REQUIRED by the Borough of Portsmouth Waterworks Company, as early as possible in the New Year. Applicants must have a good knowledge of waterworks design and construction, both practical and theoretical, and must also be good surveyors and draughtsmen. Previous personal experience in waterworks maintenance, including pumping machinery, would be an advantage, and an Associate Member of the Institution of Civil Engineers would be preferred. Salary £250 per annum, rising annually by £25 to £450.—Applications, on forms which will be provided on application to the ENGINEER and GENERAL MANAGER, Waterworks Company, Portsmouth, must be delivered not later than Friday, December 12th next. 7607

Windsor Union.
STOKER MECHANIC WANTED.
The Guardians of the Windsor Union Invite APPLICATIONS for above APPOINTMENT at the Poor Law Institution, Old Windsor. The appointment is a non-resident and whole-time one.
Salary 44 per week, no bonus.
The person appointed will be required to Take Charge of and Maintain Steam and Hot Water Boilers and Installations, Power Laundry and Steam Cooking, including Stoking of Cornish Boiler and Three Hot Water Sectional Boilers.
Applicants must be prepared (and able) to carry out the duties as prescribed in a list, which can be received from me by sending a stamped addressed foolscap envelope.
Applications to be made on forms, which will be forwarded with the list of duties referred to above, and such applications must be received by me not later than first post on Monday, 8th December, 1924, marked "Engineer."
J. E. GALE,
Clerk to the Guardians.
16, Sheet-street, Windsor,
25th November, 1924. 7651

PUBLIC NOTICES

In the High Court of Justice, Chancery Division. 1924 W. 675.
Mr. Justice Romer.
In the Matter of WATTS (FACTORS) LIMITED and
In the Matter of the COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that a PETITION was on the 20th day of August 1924 presented to the High Court of Justice by the above-named Company to CONFIRM an ALTERATION of the PROVISIONS of the MEMORANDUM with respect to the said Company's objects proposed to be effected by a special resolution of the said Company duly passed at an extraordinary general meeting of the said Company held on the 16th day of June 1924 and subsequently duly confirmed at an extraordinary general meeting held on the 1st July 1924 whereby it was resolved that the objects of the Company be extended so as to enable the Company to carry on its business more efficiently and to enlarge the local area of its operations and in particular to enable it to carry on business as Toolmakers, Cutlers, Dealers in Gold Silver and Plate, Machinists, Tool Merchants, Hardware Dealers, Manufacturers of and Dealers in Ranges, Stoves, Grates, Dairy Utensils and Agricultural Implements of all kinds, Locksmiths, Plumbers, Gas and Water Fitters, Wireless Outfitters, Leather and Grindery Factors, Colliery Factors, Builders' Merchants, House Furnishers and Dealers in Ammunition, Shooting and Sporting Requisites of all kinds and to Manufacture and Deal in articles and things usually manufactured and dealt in by persons engaged in any of the above businesses with the usual ancillary powers for the purpose.
A Print of the Memorandum of Association submitted to the said meetings containing the new sub-clauses proposed to be inserted as clause 3, and to be inserted after the original sub-clause and will be sent on request to any creditor secured or unsecured or any member of the Company, and such print of the Memorandum of Association may be inspected at the offices of the Company situate at the Garage, High-street, Lydney, in the County of Gloucester, also at the offices of the undersigned, the Solicitors of the Company.
And NOTICE IS FURTHER GIVEN that the said PETITION is directed to be HEARD before Mr. Justice Romer at the Royal Courts of Justice Strand London on WEDNESDAY the 17th DAY of DECEMBER 1924 and any person interested in the said Company whether as creditor, policy-holder, mortgagee or otherwise, desirous of opposing the making of an Order for the confirmation of the said alteration under the above Act, may appear at the time of hearing by himself or his Counsel for the purpose, and he is required to give two clear days notice in writing of his intention so to appear with the grounds of his objection, to the undersigned, the Solicitors of the Company. A copy of the said Petition will be furnished to any such person requiring the same by the undersigned on payment of the regulated charge for the same.
Dated the 21st day of November 1924.
BROOKS JENKINS and CO.,
18, Godliman-street, London, E.C. 4.
Agents for HAROLD W. BERTHON,
Esq., Lydney, Glos.,
7606 Solicitors for the above-named Company.

IRONFOUNDERS' AND STRUCTURAL ENGINEERS' BUSINESS FOR SALE BY PRIVATE BARGAIN.

The Subscribers are Prepared to receive OFFERS as a GOING CONCERN for the old-established BUSINESS (including GOODWILL, GROUND, BUILDINGS, PLANT, MACHINERY, STOCKS, &c.) carried on by JAMES ALLAN SENIOR and SON, Limited (in liquidation) at ELMBANK FOUNDRY and LAMBHILL IRONWORKS, GLASGOW.
The ELMBANK FOUNDRY, which is situated in POSSIL-ROAD, GLASGOW, covers an area of fully 4 acres and contains Moulding, Dressing and Fitting Shops, Pattern Stores and Warehouses. The Foundry is capable of a large output of Rainwater Pipes, Gutters, Soil Pipes, &c., in addition to Ornamental Ironwork and Jobbing Work.
The LAMBHILL IRONWORKS cover an area of over 10 acres. These works are well equipped with modern machinery and tools the lay-out being on the most up-to-date lines for the economical production of all classes of Constructional Steel Work.
The LAMBHILL PLANT includes one 15-Ton and two 5-Ton Overhead Electric Cranes, Straightening, Cropping, Punching, Shearing, Planing, and Sawing Machines, as well as several Batteries of up-to-date Drills, Plate Rolls, and Pneumatic Riveting Plant.
Both works are conveniently situated for transport facilities.
In addition to an old-established home trade, the company has valuable export connections.
The works may be viewed by arrangement with the Subscribers. Offers, which may be for each business separately, must be lodged with the Subscribers not later than Friday, 5th December, 1924, at Twelve o'clock Noon.
Further particulars can be obtained on application to
LYALL K. HUTCHISON,
T. L. McLINTOCK,
Joint Liquidators.
190, West George-street, Glasgow,
3rd November, 1924. 7451

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SITUATIONS OPEN

WANTED, FOUNDRY FOREMAN; Must be Fully conversant with Cast Iron Pipe Manufacture and Cupola Practice. State experience and wages expected.—Address, "FOUNDRY," Wm. Porteous and Co., Advertising Agents, Glasgow. P9847 A

WANTED, WORKS MANAGER for small Foundry employing about 35 men. Must have up-to-date methods and able to take full charge of estimating and production.—Address, 7626, The Engineer Office. 7626 A

A LARGE IRON and STEEL MANUFACTURING FIRM REQUIRES the SERVICES of a First-class ENGINEER, to Take Charge of its Plant and Drawing-office; preference will be given to a man accustomed to both modern and old plant, and who has had considerable experience in the rapid and efficient Repair of Breakages.—Applications, which would be treated in confidence, together with experience and salary required, should be addressed to 7582, The Engineer Office. 7582 A

CHIEF ENGINEER for Two Large Tanneries in Bermondsey. Must have mechanical and electrical experience, accustomed to making drawings and reporting on proposals for more economical working.—Apply in first instance by letter only, stating salary required, to MANAGING DIRECTOR, Barrow, Hepburn and Gale, Ltd., 47, Weston-street, S.E. 1. P9835 A

CHIEF ENGINEER, with Wide Mechanical and Electrical Experience, REQUIRED for abroad; Scotsman preferred; should speak Spanish and be capable of taking complete charge of large factory, with Steam Pumps, Air Compressors, Centrifugals, &c., Steam-electric Power-house, Foundry, Machine Shop, Locomotives, &c.—Write, stating age, nationality, qualifications, full details of previous experience, salary last received, and when disengaged, to "Z.A. 139," c.o. Deacon's Advertising Offices, Leadenhall-street, London. 7642 A

ENGINEER REQUIRED, to Superintend Installation of Machinery in Motor Craft. First-class work, thoroughly experienced man, permanency. Salary about £300, including fluctuating bonus.—Address, stating age, experience, 7623, The Engineer Office. 7623 A

EXPERIENCED PROGRESS MAN, Familiar with Works Planning, for large Engineering Works, 30 miles from London.—Write, stating age, experience and salary required, 7640, The Engineer Office. 7640 A

MALE TYPIST for Works Manager of Large Engineering Works, 30 miles from London; some engineering experience preferred.—Write, stating age, experience and salary required, 7648, The Engineer Office. 7648 A

MALLEABLE IRON CASTINGS.—WANTED, a good MAN with connection and who thoroughly understands this business, to organise and develop outside business in castings, in connection with firm having large foundry and at present manufacturing for own consumption only. Capacity 12 tons per week. Payment by results. Permanent and good position for right man.—Apply by letter only, giving full particulars of experience and connection, to MARTIN'S, Engineers, Stamford, Lincs. 7625 A

MANAGER WANTED, with Experience in general engineering and mechanical handling plant, also modern foundry practice. Must be capable designer. Applications treated in confidence.

Address, stating experience (in detail), age, and salary expected, P9821, The Engineer Office. P9821 A

METALLURGIST WANTED by Large Steel Manufacturers, to Take Charge of Chemical and Metallurgical Laboratory. The applicant must have good practical experience of the routine of an ordinary steel works. State particulars of education, experience, and salary expected.—Address, "METALLURGIST," Wm. Porteous and Co., Advertising Agents, Glasgow. P9842 A

RATE FIXER REQUIRED for Midland District, familiar with small work and laying out sequence of operations and quick methods of production. State age, experience, and salary required.—Address, 7499, The Engineer Office. 7499 A

REPRESENTATIVE REQUIRED.—GENTLEMAN, with good connection amongst gas and chemical works, &c., in Scotland, REQUIRED, to increase existing connection of well-known Glasgow Engineering Firm and obtain orders for Structural Work, Gas Plant, Oil Storage and Refinery Plant, &c.—Apply in writing, stating qualifications and salary required, to MANN, JUDD, GORDON and CO., 142, St. Vincent-street, Glasgow. 7464 A

TECHNICAL ASSISTANT.—WANTED by London Firm of Shipowners, TECHNICAL ASSISTANT for office. Experience of Steam and Internal Combustion Machinery essential; some knowledge of repair work desirable. Apply by letter, stating age, full details of experience and salary required. Copies of testimonials must be enclosed.—Box "TECHNICAL," c/o Advertisement Department, 5, New Bridge-street, London, E.C. 4. 7604 A

WATERWORKS ENGINEER.—WANTED, for large Waterworks in Scotland, with large scheme in hand, a TEMPORARY ASSISTANT, with good experience of Pipe-laying and Concrete Work and Contractor's Final Measurements. Salary £250. State chronological statement of experience, state of health, age and testimonials.—Address, 7640, The Engineer Office. 7640 A

WORKS SUPERINTENDENT WANTED. Experience in Petrol and Paraffin Engine Building, efficient production methods and the handling of men. State age, experience, and salary required. London district.—Address, 7627, The Engineer Office. 7627 A

AIRCRAFT DESIGN DEPARTMENT REQUIRES SERVICES of TWO First-class DRAUGHTSMEN. State experience, salary, &c.—THE H. G. HAWKER ENGINEERING CO., Ltd., Kingston-on-Thames. 7630 A

DESIGNER, Thoroughly Experienced in Overhead Travelling Cranes, not under 30 years of age.—Particulars as to salary and experience to VAUGHAN CRANE CO., Ltd., Openshaw, Manchester. 7652 A

DRAUGHTSMAN, Experienced in Steam Engines and General Engineering, expert knowledge of Fans and Centrifugal Pumps desirable, sound estimating ability essential.—Address, stating age, experience, and salary, 7605, The Engineer Office. 7605 A

DRAUGHTSMAN REQUIRED by Midland Firm of Constructional Engineers; must have experience in the design and estimating of Steel-framed Buildings.—Address, fully stating age and salary required, 7611, The Engineer Office. 7611 A

DRAUGHTSMEN REQUIRED, Experienced in Printing Press Work.—Write full particulars to R. HOE and CO., Ltd., Borough-road, London, S.E. 1. 7653 A

DRAUGHTSMAN REQUIRED, with Experience in Electrical Instrument Work; must be sound in the Design of Mechanical Details. State age, experience and salary required.—Address, 7654, The Engineer Office. 7654 A

INTERNAL COMBUSTION ENGINES.—Experienced DRAUGHTSMAN DESIGNER WANTED, must have sound knowledge of theoretical mechanics and latest practice in Diesel design and operation.—Apply by letter, stating qualifications, experience, and salary required, P9837, The Engineer Office. P9837 A

SITUATIONS OPEN (continued)

TRANSFORMER DRAUGHTSMAN.—APPLICATIONS are REQUESTED for the APPOINTMENT of a TRANSFORMER DRAUGHTSMAN with well-known British firm of electrical engineers.

Applicants must have had first-class experience in the design and manufacture of Large High-tension Transformers.

The position offers ample scope to a suitable man. Applications will be treated with strict confidence.

Address, 7508, The Engineer Office, giving full particulars of experience. 7508 A

SITUATIONS WANTED

ADVERTISER SEEKS ENGAGEMENT as MANAGER or ASSISTANT MANAGER of Cement Works; practical knowledge of rotary plants; many years' experience on large works; disengaged at short notice.—Address, P9857, The Engineer Office. P9857 B

ASSISTANT MANAGER and ESTIMATOR (36), 8 years with leading Engineer boilermakers; 15 years D.O. and works, DESIRES CHANGE; general engineering, complete boiler-house and power plant schemes; excellent references.—Address, P9855, The Engineer Office. P9855 B

CRANES, TRANSPORTERS, EXCAVATING, CONVEYING, MATERIALS HANDLING MACHINERY.—SPECIALIST in designing, estimating costs, sales correspondence, production, management, public school man, 20 years' live experience, SEEKS ENGAGEMENT, London preferred. Knowledge French, Spanish.—7, Upper Grove, South Norwood, London. P9802 B

Die-Casting, Pressure Process.
SPECIALIST
SEEKS
RESPONSIBLE POST.

Has already held positions successfully as—
Machine and Die Designer, ... 7 yrs.
Tool-room Superintendent ..... 3 yrs.
Works Manager ..... 4 yrs.
General Manager ..... 3 yrs.

Additional Experience includes—Advertising, Estimating, Selling and Costing, with
BROAD SHOP AND TECHNICAL TRAINING

Will act in either Technical or Commercial capacity, or both. Home or abroad.

Address, P9855, The Engineer Office. P9855 B

ENGINEER, with 12 Years Modern Production, planning, shop, tool design, D.O. and organising experience, DESIRES APPOINTMENT offering scope; experience gen., automobile, instruments, press work, &c.—Address, P9854, The Engineer Office. P9854 B

ENGINEER (42), with Extensive Business, Financial, manufacturing and general experience, anxious to take advantage of prospective trade improvement, SEEKS APPOINTMENT with financial or merchant house or in other connection offering further scope for qualifications. Has successful record in responsible executive positions in export, also manufacturing business. Capable organiser negotiator, &c.—Address, 7655, The Engineer Office. 7655 B

ENGINEERING EXECUTIVE at LIBERTY for POST requiring ability and resource. Wide experience of management. Good presence and address.—Address, P9851, The Engineer Office. P9851 B

ESTIMATOR DESIRES POST with Prospects; 9 years D.O. and estimating, constructional work, W.T. boilers and auxiliaries; used to handling complete boiler-house schemes; good technical knowledge.—Address, P9845, The Engineer Office. P9845 B

QUALIFIED SURVEYOR, Ex-R.N.R. Officer, navigation, pilotage, DESIRES POSITION, as Hydrographical Surveyor or similar post with harbour or conservancy board, home or abroad; excellent refs.—Address, P9843, The Engineer Office. P9843 B

EXPERIENCED MECH. ENG'R, (37), M.I. Mar. E., A.M.I. Mech. E., specialised contractors' plant; just free (finished contract), economical operation and costs, administrator, likes responsibility and can handle labour, SEEKS POSITION as Mechanical Advisor to Contractors, or that of Buyer. Would undertake inspection of plant and report. Capable of making quick and sound decisions; war service.—Address, P9834, The Engineer Office. P9834 B

MACHINERY DESIGNER, Shop Trained, 20 Years' experience design original machinery for all classes manufacture, DESIRES POST, design new or original machinery for any process.—Address, P9839, The Engineer Office. P9839 B

SALES MANAGER REQUIRES POSITION; 20 years' experience, extensive connection collieries and power stations, &c.; accustomed handle large contracts.—Address, P9850, The Engineer Office. P9850 B

STEEL FOUNDRY MANAGER and METALLURGIST DESIROUS CHANGE; years present position; excellent foundry record; experienced converter and Siemens.—Address, P9796, The Engineer Office. P9796 B

STOREKEEPER, BUYER (Experienced), SEEKS RE-ENGAGEMENT. Excellent testimonials.—Address, P9844, The Engineer Office. P9844 B

YOUNG ENGINEER, A.M.I.C.E., A.M.I. Mech. E., with thorough knowledge foundry work, pipe layout, and general mechanical engineering, SEEKS progressive BERTH as Technical Assistant, Draughtsman, Estimator, Inspector, &c. Good knowledge of costs. Not afraid of hard work.—Address, 7656, The Engineer Office. 7656 B

DRAUGHTSMAN and ENGINEER, London, 12 years shops, 14 years drawing-office, all-round experience, including patent drawings, specifications and experimental work, or private work undertaken.—Address, P9858, The Engineer Office. P9858 B

DRAUGHTSMAN, Jig and Tool, General Engineering, REQUIRES POST with Midland firm; 8 years' experience; disengaged.—Apply, S. M., 199, St. Agatha's-road, Birmingham. P9850 B

BOY, Age 18, Son of Civil Engineer in India, DESIRES OPENING in Engineering Firm. Very good draughtsman.—A. B., c/o "South African Engineering" 199, Strand, W.C. 2. P9840 B

AGENCIES

ESTABLISHED FIRM of ENGINEERS and FURNISHERS, central office Glasgow, with large connection in shipbuilding, colliery, and general industrial works, WISH TECHNICAL AGENCIES, Power Plant and Fuel Economy Accessories, &c.—Address, "TECHNICAL," Wm. Porteous and Co., Advertising Agents, Glasgow. P9841 p

WELL-KNOWN and Old-established Continental ENGINEERING FIRM, specialising in Water and Steam Turbines, Turbo-blowers, Compressors, Pumps, Papermaking and Refrigerating Machinery, &c., and having London office, WISHES to APPOINT a well-established and influential MANCHESTER FIRM as REPRESENTATIVES for surrounding districts.—Address, fully stating experience, past and present activities, particulars of staff employed, references, &c., 7610 The Engineer Office. 7610 p

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

A New Air Mail Service.

THE proposed air service between Belfast and England was considered at a meeting of the Belfast Chamber of Commerce, held a day or two ago. It was announced that a company is being formed under the title of Northern Air Lines, Limited, and that its object is to run a mail and passenger service of aeroplanes between Belfast and England. With a fleet of three aeroplanes, two of which have already been purchased, it is proposed to provide a service between Northern Ireland and England all the year round. For eight months in the year the aeroplanes will fly between Belfast and Carlisle, carrying mails and passengers each way, but during the four winter months the outgoing mails will be carried *viâ* Stranraer as at present by train. During this period the incoming mail would be transferred on arrival at Stranraer to a waiting aeroplane, and would be taken to Belfast. South-going mail trains would be met at Carlisle, thus enabling letters posted in Belfast in the evening to be delivered in London by the first post in the morning. The London letters would also reach Belfast in time for inclusion in the first delivery.

The Wembley Exhibition of 1925.

IF any doubt remained about the reopening of the British Empire Exhibition next year, it was removed on Monday last, when the Duke of Devonshire presided at a meeting of the Executive Committee at the Board of Trade. There was but little to be done, for the Prime Minister had already indicated that the new Government would look favourably on the reopening, but the meeting passed the following resolution: "That the Executive Committee recommends that the Exhibition continues during 1925, and that the existing Board, with the addition of his Grace the Duke of Devonshire, as an *ex-officio* member, be so instructed and authorised to take the necessary steps towards that end." The members of the Board are Lord Stevenson, Sir Henry MacMahon, Sir James Allen and Sir Charles McLeod. It is understood that whilst the main buildings will remain, and will be used again in many respects, the Exhibition will differ from that which has just closed. We venture to express a hope that in the few months before the reopening labour may be expended upon the making of better roads, and that in the reformation some of the vulgarities may be removed.

The Motor Ship or the Steamer.

IN his address as retiring President of the American Society of Naval Architects and Marine Engineers, copies of which have just reached this country, Captain Walter McFarland stated that in analysing the problem of steamer *versus* motor ship, he had not been led to anticipate the superseding of the former by the latter. There were, of course, services in which motor ships of a certain power and with oils at their present prices were undoubtedly attractive, but it seemed to him that the problem was not so much technical as broadly financial. The very high thermal economy of the internal combustion engine, with a consequent great reduction in fuel bills, had a tendency to arouse enthusiasm which a careful study of all conditions did not entirely warrant. The vital point, it seemed to him, was the question of the cost of fuel. All the authorities who discussed the subject of the available known sources of oil supplies warned us, he said, that they were very far from being inexhaustible. Some, indeed, were so pessimistic as to talk of the exhaustion of oil within two decades. The quantity of petrol required for motor vehicles and other purposes was constantly increasing, and that was the part of the oil business which gave the best returns. Consequently, the part available for other purposes, including heavy oil for fuel, was constantly being reduced. The law of supply and demand certainly made it plain that if steam engines were superseded by internal combustion motors, the great demand for oil would make the price so high that the thermal economy of those motors would be more than offset by the cost of fuel.

20-Ton Coal Wagons.

APPARENTLY the 20-ton coal wagons, which the Great Western Railway is introducing, and which were described in our issue of August 29th last, are a great success. They were seen at work for the first time on Friday of last week, when there was a most satisfactory demonstration at Alexandra Docks, Newport, of the shipment of 8500 tons of coal bound for Italy. Newport Docks already possess four hoists which are capable of dealing with such large wagons, and three of them could do so without any alteration whatever. Other hoists are to be altered to make them suitable for the new conditions, and new hoists are to be erected for the same purpose. The advantages of the larger wagons are several. First, the price of two 10-ton wagons is 50 per cent. more than that of one 20-ton wagon. Then there are (*a*) a saving of some 30 per cent. in siding space; (*b*) a reduction in shunting cost owing to the smaller number of wagons handled; (*c*) a saving in maintenance charges; (*d*) a reduction in hauling cost because of decreased dead load; and (*e*)—possibly the most important of all—an increase in the rate of shipment. It will be remembered that the railway company grants a rebate of 5 per cent. off conveyance rates on all coal class traffic sent wholly over its system in fully loaded 20-ton wagons.

Steel Houses.

THE report on steel houses on wooden frames, which has been prepared by a committee appointed by the Minister of Labour in the late Government, was issued on Friday of last week. The Committee, of which Sir Ernest W. Moir is chairman, is of opinion that "there is abundant evidence that houses made of steel on wooden framing can be considered as a reasonable method of providing immediate housing accommodation." Discussing the type of house advocated by Lord Weir, the report states that the Committee is satisfied that such houses can be erected rapidly, and that subject to certain criticisms, such as the greater difficulty in keeping a steel house warm than a brick one—to overcome which defect a remedy has been proposed—"no serious objection could be taken to the Weir type." Indeed, the Committee expresses itself as satisfied that that type of house is deserving of encouragement and "might form part, at least in the meantime, of the structures that go to house the people, particularly in cases where cheap land is available, where foundations are doubtful, and where, for any reason, more permanent types of buildings cannot quickly be provided." With that object the Committee suggests that local authorities and others concerned in the carrying out of housing schemes should be invited to undertake voluntarily the erection of houses of this type in sufficient numbers to enable the system to be properly tested.

Electricity in Coal Mines.

AN exceedingly interesting address, entitled "The Use and Abuse of Electricity in Mines,' was recently delivered in Glasgow by Mr. J. A. B. Horsley, the Electrical Inspector of Mines. The address was given before a joint meeting of the Mining Institute of Scotland, the National Association of Colliery Managers, and the West of Scotland Branch of the Mining Electrical Engineers' Association. After referring to the great strides made with the use of electricity in mining operations during the last twelve years, Mr. Horsley claimed that electricity was a veritable subterranean power. Formerly electricity was regarded as unreliable by mining engineers, but that that fear was groundless was proved by the fact that motors, to the aggregate of over 1,250,000 horse-power, were now installed in coal mines. Electricity differed from other forms of energy in that measurements could be simply and accurately made. Leaks could be instantly detected, and the position of faults was readily discovered. It was, moreover, possible to ascertain with great accuracy the quantity of energy which was being usefully employed. There was at present a distinct movement on foot towards the better equipment and maintenance of electrical plant in use in collieries. Money spent on that account would be well spent, for reliability and efficiency were the great points to aim at.

The Institution of Structural Engineers.

A MEETING was held last Saturday with a view to forming a Midland branch of the Institution of Structural Engineers. The proposed branch would cover the counties of Hereford, Shropshire, Staffordshire, Derbyshire, Nottinghamshire, Northamptonshire, Worcestershire, Warwickshire, Leicestershire, and Rutland. The president of the Institution, Major James Petrie, occupied the chair, and in opening the proceedings he remarked that the scope of engineering widened with every invention and discovery, and every year some fresh field of research was opened out. It was therefore, he said, desirable that engineers should be banded together for the good of the country and the Empire. The proposal to form a Midland branch of the Institution was put by Mr. W. R. Parsonage, of Wednesbury, and it was seconded by Mr. J. C. Telford, of Stourbridge, who advocated the formation of technical classes for young men at the local works. The resolution was carried, and Mr. Parsonage was elected honorary secretary. Members of the committee are Messrs. H. C. J. Carrington, of Birmingham; T. C. Telford, of Stourbridge; E. L. Cotteral, of Wolverhampton; H. J. Collins, of Birmingham; and V. H. Lawson, of Walsall.

Coal Dust and Mine Explosions.

A LECTURE on "The Nature of Coal Dust" was recently delivered in Newcastle by Professor Granville-Poole, of the Armstrong College. The danger of coal dust in underground roadways was, he said, recognised many years ago by John Buddle, an eminent North of England mining engineer, who found coal dust to be the cause of the Wallsend explosion in 1803. Later, Faraday and Lyell reported that coal dust swept from the roof, sides and floor of the roadways would instantly take fire and continue to burn if there was sufficient oxygen present to support combustion. Firedamp was not the only enemy of the miner. When, however, stone dust predominated the explosive blast was checked and extinguished. The experimental gallery at Altofts Colliery, towards which the Mining Association provided £10,000, had been a great help in connection with the investigation of this subject. It had been found that a remarkably small percentage of stone dust would check the flame, and that if from time to time the underground roadways were swept up and inert stone was applied to them an explosion could be prevented from developing. The percentage of coal dust and stone dust on the roadways was now the subject of a Government regulation.

A Burst Water Main.

THE inhabitants of Holloway, near Matlock, had an unpleasant experience early in the morning of Monday last, when a large main of the Derwent Valley Water Board burst and caused extensive flooding. The road in which the burst occurred—known as Co-operative-row—is described as having been blown up to a depth of some 20ft., and the noise of the "explosion," if we may call it so, was sufficiently loud to awaken the whole village, and was comparable with that made by blasting. Before an isolating valve could close, a large body of water, variously estimated at from 3,000,000 to 4,000,000 gallons, escaped through the ruptured main, and some houses were flooded to a depth of 5ft., while a church and school-room below it were inundated. This is, we believe, the first event of its kind which has occurred in connection with the Derwent Valley scheme, and it is fortunate that no lives were lost.

New Bridge over River Ouse.

THE West Riding County Council is to promote a Bill in Parliament for powers to construct a bridge over the river Ouse at Boothferry, two miles north-west of Goole. When the scheme was first under discussion, the provisional plans included a river span of 100ft. only, but objection was taken to the proposal in the interests of the navigation, and the new design makes provision for a steel swing bridge with a river span of 125ft. The estimated cost of the bridge and its approaches is £110,000, of which it is understood the Ministry of Transport will contribute £50,000, whilst the balance will be found by the West Riding County Council, Hull Corporation, East Riding County Council, and the Goole Urban District Council in proportions now agreed. The construction of the bridge will open up a new route between Doncaster and Hull, and will give much-needed local transport facilities for cross-river traffic over a wide area.

The Barking Strike.

ON Wednesday last, as a result of a conference between the Engineering Employers' Federation and the Electrical Trades Union, terms were reached which brought the strike of men engaged on the erection of machinery at the Barking power station to an end. It will be recalled that the dispute arose from the objection of London men to certain mechanics who had been brought to London by a Tyneside firm receiving the Tyneside rates of wages instead of the London rates. Under the agreement, which was signed on Wednesday, the firms concerned are authorised to continue their usual practice as to rates of wages payable, but the "Federation and Federated Employers and the Electrical Trades Union reserve their rights respectively to take such action as they deem desirable on any decision which may follow the deliberation of the Council"—that is, the Joint Industrial Council for the area. Hence, it appears that whilst the strike has been brought to an end, the conditions of wages under which future contracts in London shall be executed remain to be settled. The union was obviously satisfied that a satisfactory settlement of this point would be reached.

Agricultural Engineering.

A DEPUTATION representing the Agricultural Engineers' Association was received by the Committee on Industry and Trade on Wednesday last. The witnesses contrasted the state of the industry in 1913 with that ten years later. Before the war it made a gross profit of approximately 10 per cent., out of which management expenses, remuneration and income tax had to be paid. In 1923 the corresponding figure amounted to a loss of 10 per cent. Last year, not more than half the number of people were employed in the industry, whilst the average wages per man per hour were rather more than doubled. The deputation suggested as the causes of the depressed condition of the industry, first, the reduced purchasing power of the world; secondly, the loss of various export markets; and, thirdly, the high cost of production in this country since the war. The reduction of these costs is held to be the first need of the industry, and it was conditional on a substantial reduction in the cost of living. Manufacturers were endeavouring to reduce production costs, but to do so great capital expenditure was necessary, and money was difficult to obtain in view of high taxation. The deputation also asked for a more reasonable attitude on the part of the trades union to overtime.

Locomotive Cylinder Performance.

By E. C. POULTNEY, O.B.E.

No. II.*

CUT-OFF—ITS RELATION TO THROTTLING.

THE next characteristic of the steam action in the cylinder claiming attention is the subject of cut-off and its relation to throttling. Fig. 6 shows how power is related to speed and cut-off, and the variation which takes place between the pressure indicated at the point of cut-off for any rate of admission, and for each of the several speeds is shown by the curves in dotted lines. This diagram is interesting, for it shows, as a general rule, that for any given cut-off actual the increase in the indicated horse-power as the speed is increased is accompanied by a decided lowering of the pressure in the cylinders at the point of cut-off.

Bearing in mind the conclusions formed by a study of Fig. 5, where it was seen that economy at a given

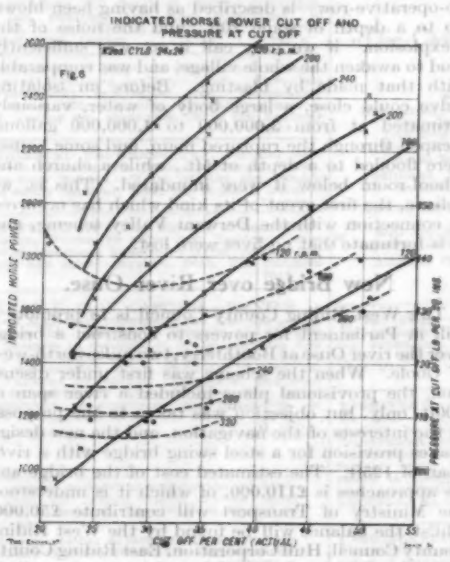

INDICATED HORSE POWER CUT OFF AND PRESSURE AT CUT OFF
Fig.6
INDICATED HORSE POWER
CUT OFF PER CENT (ACTUAL)
PRESSURE AT CUT OFF LB. PER SQ. INCH

FIG. 6

cut-off increases as the speed becomes greater, attention is again directed to the throttling action of the superheater steam ports and passages. Fig. 6 shows that the higher powers were obtained at the highest speeds, and Fig. 1 giving the relation between steam rate and power, and Fig. 3 which give information as to pressure drop and power, show respectively that the best economy was realised at the highest powers, and that the low steam rates at the highest powers were obtained when the throttling action of the superheater was most in evidence, namely, when the pressure drop was at its maximum, which Fig. 3 showed to be when the highest powers were indicated.

It would seem, therefore, that throttling or wire-drawing, while it reduces the mean pressure and hence the power, does not increase the steam rate, for when throttling or wire-drawing is due only to speed, not only does the power increase but so also does the economy in the use of the steam, although it must at the same time be borne in mind that an increase in cut-off at a given speed will also cause an increase in the pressure drop and an increase in the steam rate.

This appears to indicate that throttling in itself results only in an increased steam rate when it necessitates so long a cut-off that the loss comes through too high a release pressure. Further bearing in mind that the throttling action of the superheater is most pronounced at the higher powers and hence at the greater rates of evaporation and consequent higher steam temperatures, it is probable that the pressure drop is largely offset by the larger steam volume, and the decrease in the heat units supplied to the cylinders per horse-power developed.

In connection with the above it should be pointed out that, although at the higher powers the shortest cut-off gives the best economy in the use of steam, it is at the same time probable that whatever the indicated horse-power developed the cut-off should not at any time be so short that the resulting release pressure is lower than, or possibly as low as, the least back pressure required for the blast, and consideration of this feature may mean that in order to prevent too low a release pressure it might be necessary to run with a longer rate of admission and throttle, that is, partially closing the "regulator" in order to obtain the required power.

The following paragraph, "Full Throttle *v.* Partial Throttle," shows, however, that so far as economy is concerned, there is a decided loss by such working.

The following tabulation taken from Bulletin 21, "Tests of a Class E 6 s. Passenger Locomotive," gives the respective pressure drops for each of the several tests, and brings out the fact that the pressure drops are greater for a given cut-off through the range of speeds at which the trials were made than those shown for given speeds and at successively increasing rates of admission.

Nom. cut-off per cent.	Revolutions per minute.						
	120	160	200	240	280	320	360
	Drop in pressure, pounds per square inch.						
20	2.0	—	5.8	5.4	7.8	8.0	9.7
—	—	—	—	—	—	8.5	—
25	3.4	4.3	4.5	8.1	10.1	11.3	12.5
30	3.0	4.2	—	8.0	10.7	—	14.0
35	—	5.0	7.3	—	12.0	—	—
38	—	—	—	11.0	—	—	—
40	5.0	—	—	—	—	—	—
50	—	8.3	10.7	—	—	—	—
			11.2				

FULL THROTTLE *v.* PARTIAL THROTTLE.

In order to determine the effect on the consumption of fuel and steam by running with the "throttle"

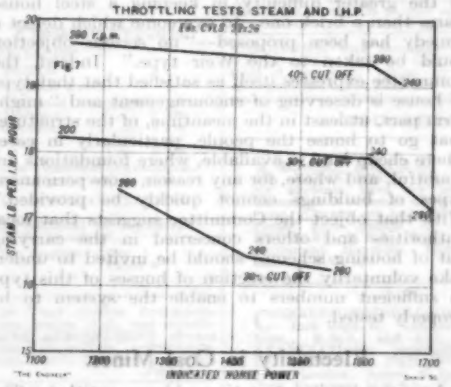


FIG. 7

or "regulator" partially closed, and at a longer cut-off than necessary for a given power output, six tests were run with the engine E 6 *s.* at various speeds. The results are summarised in Table III., and shown in graphic form by Figs. 7 and 8, giving the steam

TABLE III.—*Water and Coal Rate, Full versus Partial Throttle.—"Atlantic" Type Engine, No. 89, Class E 6 s (Superheated).*

Revs. per min.	Nom. cut-off, per cent.	Throttle.	Steam to engines, lb. per hour.	Dry coal fired, lb. per hour.	Smoke-box draught, inches water.	Power. I.H.P.	Power. D.H.P.	Steam pressures. Boiler.	Steam pressures. Branch pipes.	Superheat, deg. Fah.	Coal per I.H.P.	Coal per D.H.P.	Steam per I.H.P.	Steam per D.H.P.
200	20	Full	21,393	2733	4.3	1228.8	871.0	202.5	196.7	177.57	2.22	3.14	17.41	24.56
240	20	Full	23,395	2944	6.8	1424.0	1136.0	205.0	199.6	189.84	2.07	2.59	16.43	20.59
280	20	Full	25,232	3092	6.6	1544.1	1085.7	204.0	196.2	197.87	1.99	2.85	16.24	23.24
200	30	Partial	20,758	2536	4.4	1139.8	876.2	201.1	140.0	190.43	2.22	2.89	18.21	23.69
240	30	Partial	28,781	3636	7.0	1606.1	1119.7	204.9	172.6	211.62	2.26	3.25	17.92	25.70
280	30	Partial	29,179	3765	8.2	1700.5	1065.7	205.6	162.6	229.82	2.21	3.53	17.16	27.38
200	40	Partial	22,690	2654	5.1	1154.1	886.6	203.4	115.0	224.92	2.30	2.99	19.66	25.59
240	40	Partial	31,561	4266	10.0	1656.6	1125.5	203.9	142.6	263.32	2.57	3.78	19.05	28.04
280	40	Partial	31,111	4177	9.5	1610.4	1096.4	204.9	126.9	228.09	2.59	3.81	19.32	28.38

For equal dynamometer horse-powers working with a partial throttle and at longer cut-offs increases the fuel and steam rates per horse-power hour. The steam supply to the engines is increased and hence the evaporation, so also are the rates of combustion and the smoke-box draught readings. The temperature of the superheated steam is higher.

rates plotted against the indicated and dynamometer horse-powers.

The full throttle tests made at a nominal cut-off at 20 per cent., and at 200, 240 and 280 revolutions are compared with six others at the same speeds, but at 30 and 40 per cent. cut-off, the throttle being partially closed till approximately the same dynamometer horse-powers were obtained. An interesting point brought out is that the D.H.P. at 280 revolutions per minute is less than at 240 revolutions per minute, irrespective of the cut-off. Further, this same result is obtained at 40 per cent. cut-off—the longest tried. It would seem that this effect is due to the pressure drop in the branch pipe, which was lower in each case at 280 than at 240 revolutions per minute. Bearing in mind the conclusions formed when analysing the effects of the throttling action of the superheater steam ways and the effect of cut-off and its relation to throttling, these results and their causes are what would be expected.

The results of the tests so far as the fuel and steam rates are concerned are conclusive. They show beyond question that throttling and running at a longer cut-off than is necessary for a given power increases both the fuel and steam consumption per unit of power. It can be said that 20 per cent. cut-off or shorter gives the best performance, and, furthermore, if 20 per cent. cut-off does not give sufficient power, then larger cylinders with the same cut-off would give more economical results.

INDICATOR DIAGRAMS FOR SUPERHEATED AND SATURATED STEAM.

Diagrams:—(1) *At Equal Rates of Cut-off.*—The information upon this subject refers to certain tests made with the "Pacific" type engine Class K 2, cylinders 24 by 26, and K 2 *sa.*, having the same sized cylinders. Both engines have the same boiler steam pressure, namely, 205 lb. per square inch. Fig. 9, reproduced from Bulletin 18, "Tests of a Class K 2 sa. Locomotive," gives the two diagrams superimposed. The only difference is the fact that for K 2 *sa.* the steam was superheated 236 deg. Fah.,

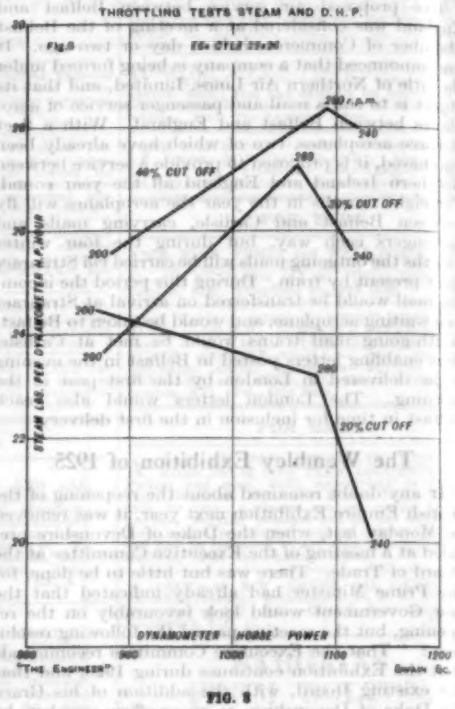
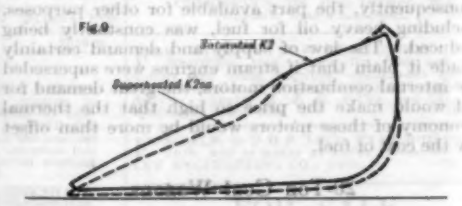


FIG. 8

whilst K 2 worked with saturated steam. The effects due to the use of superheated steam should be noted. Superheated steam in equal-sized cylinders and at an equal rate of cut-off develops slightly more power than saturated steam—1849.4 against 1816.0 indicated horse-power. This increase in power is due

INDICATOR DIAGRAMS FOR SATURATED AND SUPERHEATED STEAM FOR EQUAL RATES OF CUT OFF PER CENT.



	K2sa	K2
Cylinders	24x26	
Steam Pressure	205	
Speed 180 r.p.m.	42 m.p.h.	
Superheat Degs. Fah.	236	–
Cut off per cent	37	37
M.E.P.	88·0	84·8
I.H.P.	1849·4	1816·0
Steam per hr. lb.	33,491	48,553
" " I.H.P. hr. lb.	18·1	26·7

"THE ENGINEER" SWAIN SC.

FIG. 9

power, and the saturated steam engine required 48,553 lb. for 1816 indicated horse-power, giving steam rates of 18.1 lb. and 26.7 lb. per indicated horse-power hour. For equal powers the superheater engine requires 15,736 lb. less steam per hour than the

* No. I. appeared November 21st.

saturated steam engine, representing a saving of 32 per cent.

(2) *Results at Equal Rates of Steam Consumption.*—Indicator diagrams for nearly equal weights of steam supplied to the engines per hour are given by Fig. 10. The quantities of steam supplied are not exactly the same; there is, it will be observed, a difference

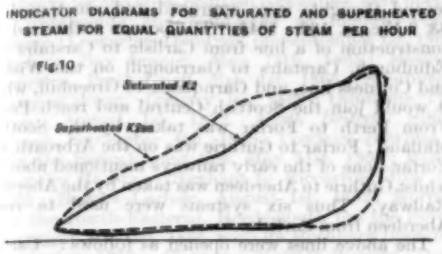

INDICATOR DIAGRAMS FOR SATURATED AND SUPERHEATED STEAM FOR EQUAL QUANTITIES OF STEAM PER HOUR
Fig.10
Saturated K2
Superheated K2sa
Cylinders 24x26
Steam Pressure 205
Speed 160 r.p.m. 38 m.p.h.
K2sa K2
Superheat Degs. Fah. 268 —
Cut off per cent. 51 37
M.E.P. 110·2 88·7
I.H.P. 2047·6 1657·4
Steam per hr. lb. 39,049 40,558
" I.H.P. hr. lb. 19·1 24·5
"The Engineer" Dwgs. 5c

FIG. 10

of 1507 lb. in favour of K 2 sa. or the superheater engine, but there is a net increase in indicated horse-power by superheating of 28 per cent. when equal weights of steam are supplied to the engines per hour.

Cylinder Dimensions.

From Fig. 8 it will be seen that when consuming approximately equal weights of steam per hour K 2 sa. using superheated steam was operated with a 51 per cent. cut-off which, on the basis of steam consumption only, Fig. 6 showed to be wasteful in the heat rate per indicated horse-power hour. It has been shown that larger cylinders, if necessary, may be used together with a short cut-off, and equal or more power obtained and also equal or greater economy realised. The diagram—Fig. 8—furnishes means for computing the size of new cylinders which would result in better use being made of the greater steam supply due to superheating.

Assuming that the cut-off at which K 2 was being run, namely 37 per cent., is satisfactory, the size of a new cylinder for K 2 sa., which would operate at cut-offs no longer than those used for K 2 and develop at each point more power, can be established. K 2 develops with a cut-off of 37 per cent., a mean pressure of 89 lb. nearly. For the same weight of steam, when using superheated steam, the ratio of piston areas must be equal to the ratio of the mean effective pressures, which are 110 lb. and 89 lb. for the superheated and saturated steam engines respectively. From which a simple calculation shows that a 26¼in. cylinder would be required. It may, therefore, be said that when a change from saturated to superheated steam is made, other things being equal, *i.e.*, piston speed, steam consumption, cut-off and mean pressure, the cylinders which were satisfactory prior to the fitting of a Schmidt type superheater to a given locomotive may be with advantage increased in capacity by about 20 per cent., furnishing at least a corresponding increase in power for a given hourly steam supply to the engines.

Coal and Water Savings.

The effect of the addition of a flue tube superheater furnishing highly superheated steam to a given locomotive has been very clearly shown when considering the indicator cards obtained at equal rates of cut-off, and for equal conditions as regards the steam suppiy to the engines. At equal rates of admission superheated steam gives greater power, and at a steam rate in the case of K 2 sa. and K 2 engines, of 18.1 lb. as against 26.7 lb. for saturated steam in equal cylinders, representing a saving of 32 per cent., whilst for equal weights of steam supplied the gain in indicated horse-power is 28 per cent. in favour of the superheater equipped locomotive.

The diagrams—Figs. 11 and 12—however, bring out more strikingly the effect of working with superheated as opposed to saturated steam. In Fig. 11 the steam rates of certain engines working with saturated and superheated steam are shown plotted against indicated horse-powers. All the locomotives included in the graph have 205 lb. boiler pressure,

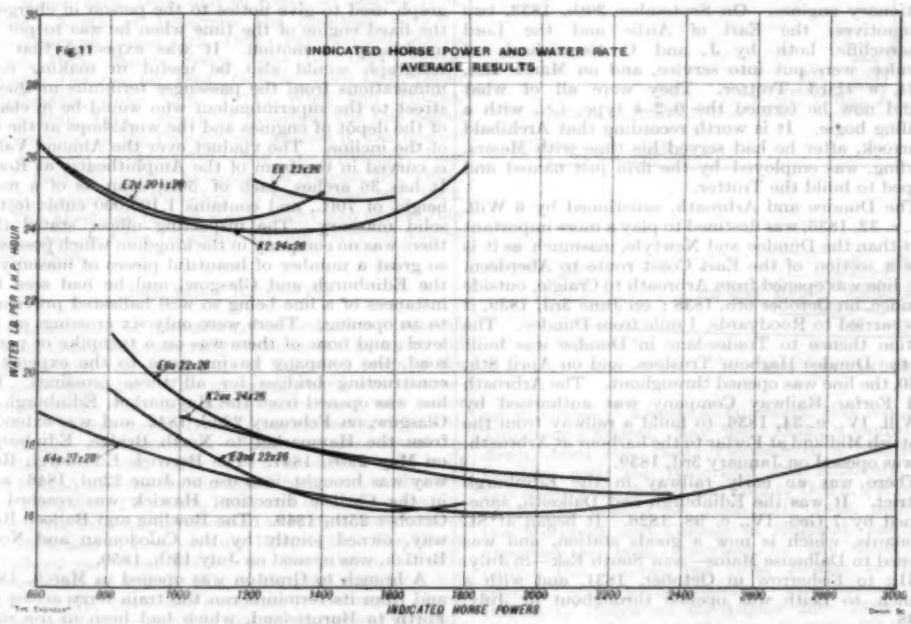


FIG. 11

and all have 80in. drivers, and all, save the 4–6–2 engines K 4 s., have 26in. piston stroke. E 2 d. and E 3 sd. are light "Atlantics," alike except for the superheater equipment fitted to E 3 sd., and the difference in the cylinder diameters. E 6 and E 6 s., Nos. 5075 and 89, and K 2 and K 2 sa. are the "Atlantic" and "Pacific" type engines, forming the basis of this article.

The curves in the graph indicate in an unmistakable manner the advantages obtained by substituting superheated for saturated steam; not only are large savings shown in the steam required per unit of power developed, but, what is also of importance, is the greatly increased capacity seen to be possible. This gain is the more remarkable when it is considered that the several classes of engines compared have equal grates and boilers. The comparative particulars in this respect are given in Table IV.

Locomotive E 2 d. is seen to give good results between 1000 and 1200 indicated horse-power when the steam rate is 24.3 lb. per horse-power hour, whilst the limit of its capacity is reached at 1400 indicated horse-power when the steam rate is 25 lb. E 3 sd., on the other hand, can develop 1600 indicated horse-power on a steam consumption of 16.2 lb., and can give 1800 indicated horse-power on a steam rate of 16.4 lb. per hour. Similarly, K 2 is economical between the limits of 1200 and 1400 indicated horse-power, at which powers the steam rate was 24 lb. per indicated horse-power hour, and K 2 sa., at 1600 indicated horse-power, requires but 17.5 lb. and at 2200 indicated horse-power only 17 lb. of steam per horse-power hour. E 6 between 1200 and 1600 indicated horse-power requires from 25.4 lb. to 24.9 lb. of steam per indicated horse-power, and the superheater engine, E 6 s., between the same limits of power, requires only 18.2 lb. to 17.4 lb. of steam, and at 2400 indicated horse-power only 16.5 lb. is necessary per indicated horse-power hour. This latter figure represents the limit of its capacity,

Table IV.—*Particulars of Locomotives, Saturated and Superheated, Compared for Steam Rates, Fig.* 11.

Class.	Type.	Sup. or sat. steam.	Total heating surface, sq. ft. (combined)	Grate area, sq. ft.	Drivers dia., inches.	Cylinders, diameter and stroke.	Boiler steam pressure.	I.H.P.	Steam rate, sat. steam.	Steam rate, sup. steam.	Saving by superheater at equal power, per cent.
E 2 d	4–4–2	No	2446.5	55.3	80	20½ × 26	205	1200	24.3		
E 3 sd	—	Yes	2854.6	54.7	80	22 × 26	205	1200		17.2	25.1
E 6	—	No	3618.6	54.7	80	22 × 26	205	1600	24.9		
E 6 s	—	Yes	3348.2	55.2	80	22 × 26	205	1600		17.4	30.1
K 2	4–6–2	No	4650.1	53.3	80	24 × 26	205	1400	24.0		
K 2 sa	—	Yes	4633.7	53.7	80	24 × 26	205	1400		17.8	21.6
K 4 s	—	Yes	5207	69.2	80	27 × 28	205	2000		16.1	

Remarks.—The indicated horse-powers given are those at which the saturated steam engines showed the best water rates per indicated horse-power hour. The same is the case for K 4 s working with superheated steam.
Heating Surfaces.—Tubes and flues, water contact surfaces; fire-box and elements, fire contact surfaces.

comparing in this respect with 1600 indicated horse-power for E 6 working with saturated steam.

The larger "Pacific" class, K 4 s., particulars of which will be found in The Engineer of June 6th, 1919, are shown as being able to furnish powers varying from 1000 to 2800 on a maximum steam rate of some 17.5 lb. of steam, and to develop a maximum of 3000 indicated horse-power on a consumption of less than 19 lb. per horse-power hour. Between 1800 and 2000 indicated horse-power the steam rate is but 16 lb.

The effect of speed alone is shown by Fig. 12, where steam consumption has been plotted against piston speed in feet per minute. Here again is indicated the effect of superheating. E 2 d. and E 2 a. work with saturated steam and the other engines with superheated steam. The superheater engines run at higher speeds and are shown to be much more economical.

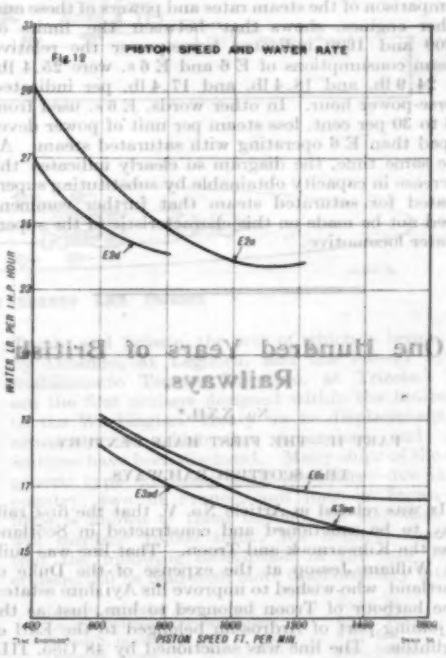


FIG. 12

The economy increases as the speed becomes higher, and for K 2 sa., having the largest cylinders, maximum economy does not appear to have been reached at the highest piston speed (about 1600ft. per minute) attained. For fast running superheated steam should give better results both as regards steam rate and possible speed than saturated steam, and for a given size of boiler and grate an increase in capacity of about 20 to 30 per cent. may be expected.

In order to show how the application of a superheater affects the coal rate per indicated horse-power* Table V. has been prepared. It gives the results obtained with the 4–4–2 type engine E 6 working with saturated steam compared with those obtained with E 6 s. working superheated. As before stated, the engines are alike except for such changes in the boiler heating surfaces as are brought about by the installation of the thirty-six element Schmidt type superheater with which E 6 s. is equipped.

* The same kind and quality of coal was used for both the locomotives E6 saturated and E6s superheated.

The results given in the table indicate that under similar operating conditions the saving that may be

TABLE V.—*Coal Consumptions, Saturated and Superheated Steam.*

Revs. per min.	Cut-off by indicator.	Speed, miles per hour.	I.H.P.	Coal dry per I.H.P.	Saving per cent.	Loco. class.
120	27.3	28.6	1042.7	2.8		E6
120	27.8	28.2	973.7	2.23	20.3	E6s
160	29.9	38.1	1260.7	2.9		E6
160	29.4	37.7	1265.1	2.33	19.6	E6s
200	29.8	47.7	1466.6	3.17*		E6
200	30.8	47.1	1529.3	2.19	27.7	E6s
240	34.1	57.2	1529	5.5†		E6
240	35.7	56.5	1675	2.39	40.0	E6s

* This is the average result obtained from four tests made at 200 revolutions, 25 per cent. cut-off and full throttle.

The speed in revolutions was constant for the tests, and the difference in the speed in miles per hour is due to there being a slight difference in the actual circumference of the driving wheels as measured.

† Boiler pressure 173 lb.; for other test the pressure ranged close to 205 lb., the working pressure.

expected by superheating is from 20 to about 40 per cent. in the coal required per indicated horse-power hour, and, furthermore, the greater the power the larger will be the economies realised when the engines compared are alike (except for the superheater equipment) and are operated under similar conditions. The superheater locomotive gives a greater indicated horse-power under similar conditions and the difference is more pronounced as the speed and power increase.

It is also interesting to note that the cut-off by the indicator is shown to be later in the case of the superheater engine. That is doubtless due to the difference in the quality of the steam; that is to say, the superheated steam is a more perfect gas than the saturated, and for that reason passes more easily through a finer port opening. That, and the fact that it exhausts with a less back pressure, accounts for the higher power developed in equal cylinders owing to the higher mean pressure obtained for the reasons stated.

A comparison of the performance of these two engines E 6 s. and E 6 leads to the assumption that high temperature superheating will furnish savings in fuel ranging from 20 to as much as about 40 per cent. at similar powers. Table IV. shows on the basis of steam consumption, and under conditions favourable to the engine E 6 working with saturated steam, that superheating improved the steam rate by 30 per cent., whilst Fig. 9, which gives a general comparison of the steam rates and powers of these and other engines, shows that between the limits of 1200 and 1600 indicated horse-power the relative steam consumptions of E 6 and E 6 s. were 25.4 lb. to 24.9 lb. and 18.4 lb. and 17.4 lb. per indicated horse-power hour. In other words, E 6 s. used from 28 to 30 per cent. less steam per unit of power developed than E 6 operating with saturated steam. At the same time, the diagram so clearly indicates the increase in capacity obtainable by substituting superheated for saturated steam that further comment need not be made on this characteristic of the superheater locomotive.

One Hundred Years of British Railways.

No. XXII.*

PART II.—THE FIRST HALF CENTURY.

THE SCOTTISH RAILWAYS.

IT was related in Article No. V. that the first railway to be sanctioned and constructed in Scotland was the Kilmarnock and Troon. That line was built by William Jessop at the expense of the Duke of Portland, who wished to improve his Ayrshire estates. The harbour of Troon belonged to him, just as the adjoining port of Ardrossan belonged to the Earl of Eglinton. The line was sanctioned by 48 Geo. III., c. 46, 1808, and was opened in 1811. A description of it was given in the article above referred to. No other railway was built in Scotland prior to the Stockton and Darlington being authorised in 1821. The first after that event was one of a series in the neighbourhood of Glasgow, and it will be convenient to deal with the railways forming this series together.

The first was the Monkland and Kirkintilloch which, under 5 Geo. IV., c. 49, 1824, was to run from the ironworks at Palace Craig near Old Monkland—west of Airdrie—to the Forth and Clyde Canal at Kirkintilloch. It was built in order to cheapen the transport of coal from the Monkland coalfield to Glasgow, and was opened in October, 1826. In 1843 the standard gauge was provided and the railway improved.

A little-known fact about the Monkland and Kirkintilloch is that the stretch of 52 chains between Garnqueen South Junction and Gartsherrie is now part of the route taken by the London, Midland and Scottish trains to and from Perth and North thereof. The Caledonian Railway Company—now included in the London, Midland and Scottish system—obtained powers from the Monkland and Kirkintilloch, under 8 & 9 Vic., c. 162, to run over that length in order to reach the Castlecary branch on its way to join the Scottish Central at Greenhill and, thereby, to reach Perth. In due time this short section passed, along with the Monkland Railway, into the hands of the Caledonian Company's principal competitor—the North British—but the facilities remain.

Two small neighbouring railways, sanctioned in 1826 and 1835 respectively, were the Ballochney—opened on July 8th, 1828—and the Slamannan—opened on August 31st, 1840. In the former year there was also sanctioned, by 7 Geo. IV., c. 103, the Garnkirk and Glasgow Railway, which ran from Gartsherrie on the Monkland and Kirkintilloch, by Garnkirk, to a terminus in Glebe-street, now part of the St. Rollox mineral yard. It was opened in May, 1831.

The Wishaw and Coltness was a railway that began by a junction with the Monkland and Kirkintilloch at Whifflet, and ran through Motherwell and Wishaw to Coltness, where it served some collieries. It was sanctioned by 10 Geo. IV., c. 107, 1829, was partly opened in 1834, and completed on January 8th, 1842.

The next stage was the extension in 1845 of the Garnkirk line from Gartsherrie, through Coatbridge, to Whifflet, and the change of its name to the Glasgow, Garnkirk and Coatbridge Railway. The Monkland and Kirkintilloch and the Garnkirk and Glasgow lines had no physical connection at Gartsherrie. That was, however, provided when the Caledonian opened its line from Carlisle and was brought into use on August 7th, 1848.

The next series of early Scottish railways to be noted is composed of those in the Dundee district, of which the first was the Dundee and Newtyle, authorised by 7 Geo. IV., c. 101, 1826, to make a railway from Dundee to Newtyle. On that line there were three inclined planes. One, the Law incline, started at the Dundee terminus in the Ward-road, and was 42 chains long, on a gradient of 1 in 10, and included a tunnel 330 yards in length. Nearly 5 miles further on was Balbeuchly inclined plane, 1690 yards long and rising 1 in 25. The last 1025 yards of the line took it down Hatton inclined plane of 1 in 12½, at the foot of which was Newtyle Station. When the line was opened in December, 1831, the level portions were worked by horses, and the inclined planes by stationary engines. On September 30th, 1833, two locomotives, the Earl of Airlie and the Lord Wharncliffe, both by J. and C. Carmichael, of Dundee, were put into service, and on March 2nd, 1834, a third—Trotter. They were all of what would now be termed the 0-2-4 type, *i.e.*, with a trailing bogie. It is worth recording that Archibald Sturrock, after he had served his time with Messrs. Stirling, was employed by the firm just named and helped to build the Trotter.

The Dundee and Arbroath, sanctioned by 6 Will. IV., c. 32, 1836, was destined to play a more important part than the Dundee and Newtyle, inasmuch as it is now a section of the East Coast route to Aberdeen. The line was opened from Arbroath to Craigie, outside Dundee, on October 6th, 1838; on June 3rd, 1839, it was carried to Roodyards, 1 mile from Dundee. The section thence to Trades-lane in Dundee was built by the Dundee Harbour Trustees, and on April 8th, 1840, the line was opened throughout. The Arbroath and Forfar Railway Company was authorised by 6 Will. IV., c. 34, 1836, to build a railway from the Scottish Midland at Forfar to the harbour at Arbroath. It was opened on January 3rd, 1839.

There was an early railway in the Edinburgh district. It was the Edinburgh and Dalkeith, sanctioned by 7 Geo. IV., c. 98, 1826. It began at St. Leonards, which is now a goods station, and was opened to Dalhouse Mains—now South Esk—in July, 1831; to Fisherrow in October, 1831, and with a branch to Leith was opened throughout in July, 1838.

Coming now to the railways more particularly on the Clyde and in the south-west of Scotland, it may be observed that in that district, besides the Kilmarnock and Troon, there were two early railways. The first of them joined Johnston and Ardrossan. By 46 Geo. III., c. 75, 1806, a canal was sanctioned between Port Eglinton and Ardrossan. Owing to financial reasons it was only built between Port Eglinton and Johnston, and by 7 & 8 Geo. IV., c. 87, 1827, a railway was substituted for the remaining 22 miles. Even this length did not get constructed; all that materialised was a railway between Ardrossan and Kilwinning, 5½ miles, opened on June 10th, 1836. The second early railway was the Paisley and Renfrew—5 & 6 Will. IV., c. 85, 1835—opened in May, 1837, and worked by horses.

The initiation of the Caledonian Railway was most interesting. By October 31st, 1838, there was through rail communication between London and Preston, and by June 25th, 1840, the railway had reached Lancaster and was within 80 miles of the Scottish border. At the latter period rail communication towards Scotland, *viâ* the East Coast, had only reached York, and it seemed, therefore, that the better route for a line to serve Scotland would be by Carlisle. Locke was asked by the Grand Junction Company to survey the line for a railway to Glasgow. The route north of Carlisle chosen by him ran *viâ* Dumfries and Nithsdale, but, later, he selected one *viâ* Annandale and Lanarkshire. The Government meanwhile had appointed Sir Frederick Smith, the chief inspector of the Railway Department, and Professor Barlow—father of W. H. Barlow—to report as to the routes to be taken for railway communication to Ireland and to Scotland. These gentlemen reported, as regards Scotland, in favour of the Annandale route. Bills for the rival schemes were deposited, and after a parliamentary contest, that cost its supporters £75,000, Locke's second thoughts were approved and sanctioned by 8& 9 Vic., c. 162, 1845. The powers authorised the construction of a line from Carlisle to Carstairs and Edinburgh, Carstairs to Garriongill on the Wishaw and Coltness line, and Garnqueen to Greenhill, where it would join the Scottish Central and reach Perth. From Perth to Forfar was taken by the Scottish Midland; Forfar to Guthrie was on the Arbroath and Forfar—one of the early railways mentioned above—whilst Guthrie to Aberdeen was taken by the Aberdeen Railway. Thus six systems were used to reach Aberdeen from Carlisle.

The above lines were opened as follows:—Carlisle to Beattock, September 10th, 1847; Beattock to Edinburgh and Carstairs to Garriongill, February 15th, 1848. The length from Garriongill to Garnqueen South Junction was on the old railways already mentioned; Garnqueen South Junction to Greenhill was opened on August 7th, 1848; Greenhill to Perth, May 22nd, 1848; and Perth to Forfar on August 2nd, 1848; the Forfar to Guthrie was on the already opened Forfar–Arbroath; Guthrie to Ferryhill, outside Aberdeen, was opened April 1st, 1850; and Ferryhill to Aberdeen on August 2nd, 1854. The stretch from Perth to Dundee was opened May 24th, 1847. Glasgow passengers passed over the Garnkirk line to Glebe-street until November, 1849, when a line from Milton Junction to Buchanan-street Station was opened.

The Edinburgh and Glasgow Railway was authorised by 1 & 2 Vic., c. 58, 1837. It was inspected by Lieut.-Colonel Sir Frederick Smith in September, 1841, in whose report reference was made to the Glasgow incline, 1 in 43, falling towards Glasgow for 2077 yards. On this section occurs the Glasgow tunnel, 1148 yards long, and divided into three portions, connected by open cuttings each 40ft. long. Sir Frederick Smith said that the incline was to be worked by stationary power, and the electrical telegraph used to give notice to the person in charge of the fixed engine of the time when he was to put his machinery in motion. It was expected that the telegraph would also be useful in making communications from the passenger terminus in Queen-street to the superintendent who would be in charge of the depôt of engines and the workshops at the top of the incline. The viaduct over the Almond Valley is curved in the form of the Amphitheatre at Rome. It has 36 arches, each of 50ft. span, is of a mean height of 70ft., and contains 1,105,000 cubic feet of solid masonry. The inspecting officer stated that there was no company in the kingdom which possessed so great a number of beautiful pieces of masonry as the Edinburgh and Glasgow, and he had seen few instances of a line being so well ballasted previously to an opening. There were only six crossings on the level; and none of them was on a turnpike or parish road, the company having gone to the expense of constructing bridges for all these crossings. The line was opened from the Haymarket, Edinburgh, to Glasgow, on February 22nd, 1842, and was extended from the Haymarket to North Bridge, Edinburgh, on May 29th, 1847. The Berwick-Edinburgh Railway was brought into use on June 22nd, 1846, and, in the Carlisle direction, Hawick was reached on October 25th, 1849. The Bowling and Balloch Railway, owned jointly by the Caledonian and North British, was opened on July 15th, 1850.

A branch to Granton was opened in March, 1848, and from its terminus ran the train ferry across the Forth to Burntisland, which had been in use since September 15th, 1844. The line from Burntisland to Cupar and Lindores was opened on September 20th, 1847; the Glenburnie curve at Lindores on December 9th, 1847; the stretch from Cupar to Ferry-Port-on-Craig and from Glenburnie to Abernethy, on May 17th, 1848; and from Abernethy to Hilton Junction, near Perth, where a connection was made with the Scottish Central, on July 18th following.

Coming now to what became the Glasgow and South-Western Railway it may be noted that by 1 Vic., cc. 116 & 117, 1837, there were respectively sanctioned the Glasgow, Paisley and Greenock and the Glasgow, Paisley, Kilmarnock and Ayr. These railways were to build jointly a line between Glasgow, Bridge-street, and Paisley. The former was then to be continued to Greenock, and the latter to Ayr and to Kilmarnock. The Kilmarnock made the greater progress and a portion, *i.e.*, between Irvine and Ayr, was opened first—on August 5th, 1839—and then from Irvine to Glasgow, including the joint line, on July 24th, 1840. The line from Dalry to Kilmarnock followed on April 4th, 1843, and the last section to be opened was from Irvine to Busby in May, 1848. An extension from Kilmarnock was made to Auchinleck on August 9th, 1848. The Ayr and Girvan reached Maybole on October 13th, 1856, and Girvan on May 24th, 1860. The Ayr and Dalmellington was opened on August 7th, 1856. The Glasgow and South-Western main line was brought into use thus:—Gretna to Dumfries on August 23rd, 1848; Dumfries to Closeburn,

* No. XXI. appeared November 21st.

October 15th, 1849; and Closeburn to Auchinleck on October 28th, 1850. Situated on the Glasgow and South-Western, between Auchinleck and Mauchline, is the Ballochmyle Viaduct, which is 630ft. long, has six approach spans of 50ft. each, and a central span of 181ft.—probably the longest masonry arched span in existance. The highest point is 157ft. 4in. above the river Ayr.

The principal extensions of the first half century of railways for the chief Scottish companies were opened in instalments and completed as follows:—*Caledonian:* Lockerbie–Dumfries, on September 1st, 1863; Wemyss Bay branch, May 15th, 1865; Methven Junction, Perth–Crieff, May 1st, 1866; Edinburgh–Glasgow direct, January 1st, 1869; Dunblane–Tyndrum, August 1st, 1873. *North British:* Silloth branch, September 4th, 1856; Cowlairs–Bowling to join the Balloch joint line, May 31st, 1858; Border Counties Railway—Hexham to Riccarton, July 1st, 1862; Hawick–Carlisle, August 1st, 1862; Morpeth (on the North-Eastern), Reedsmouth (on the Border Counties), May 1st, 1865, with its Rothbury branch in November, 1870. *Glasgow and South-Western:* Dumfries–Castle Douglas, November 1st, 1859; Castle Douglas–Stranraer, March 12th, 1861; Stranraer–Portpatrick, August 28th, 1862; Kirkcudbright branch, August 16th, 1864; Greenock branch, September 1st, 1869; Newton Stewart–Garliestown, August 2nd, 1875.

The various sections of the Great North of Scotland were brought into use as follows:—Elgin–Lossiemouth on August 10th, 1852; Ferryhill to Banchory on September 8th, 1853; thence to Aboyne on December 2nd, 1859; and to Ballater on October 17th, 1866. From Aberdeen to Huntley was opened on September 19th, 1854; Craigellachie was reached on October 10th, 1856, and Elgin on December 23rd, 1858. The Alford, Macduff, Banff and Portsoy and the Peterhead branches were respectively brought into use in March, 1859, August, 1859, June, 1860, and July, 1862. From Craigellachie to Grantown was opened on July 1st, 1863, and thence to the Highland at Boat of Garten on August 1st, 1866. The Fraserburgh branch was put into service on April 24th, 1865.

The first section of the Highland was from Inverness to Nairn on March 23rd, 1855, and it was extended to Dalvey on December 22nd, 1857, to Elgin on March 25th, 1858, and to Keith on August 18th, 1858. North of Inverness the openings were:—To Dingwall, June 11th, 1862; Invergordon, March 23rd, 1863; Meikle Ferry, June 1st, 1864; Bonar Bridge, October 1st, 1864; Golspie, April 13th, 1868; Helmsdale, June 19th, 1871; Wick and Thurso, July 28th, 1874. South of Inverness the line began at Stanley on the Caledonian, whence it was opened to Dunkeld on April 7th, 1856; to Pitlochry, June 1st, 1863; Forres to Aviemore on August 3rd, 1863; and Aviemore to Pitlochry on September 9th, 1863.

The Aberfeldy branch was brought into use on July 3rd, 1865, and the Dingwall–Strome Ferry on August 19th, 1870.

The Irish Railways.

The history of the railways of Ireland is confused, full of detail and, generally, tedious, and so we intend only to give the particulars of the early years of the main companies. The opening phase was characteristic—the first line to be sanctioned was never built. It was to run from Limerick to Carrick, with a branch to Waterford, which was sanctioned by 7 Geo. IV., c. 139, 1827. The first railway to be built in Ireland was the Dublin and Kingstown, authorised by 1 & 2 Will. IV., c. 69, 1831, and opened on December 17th, 1834, being extended to Kingstown Harbour in 1839, and to Bray on July 10th, 1854. The Ulster Railway ran from Belfast to Portadown. It was sanctioned by 6 Will. IV., c. 33, 1836, and by 8 & 9 Vic., c. 110, 1845, was extended to Armagh. A remarkable feature of it was that the gauge was 6ft. 2in., which was that recommended by the Commission—known as the Drummond Commission—on Railway Communication in Ireland appointed in 1836. But within seven years of the issue of this document the Commission's recommendations were repudiated, as the Act, just mentioned, sanctioning the extension to Armagh, ordered the gauge of the Ulster Railway to be altered to 5ft. 3in., the same as that adopted for the Dublin and Drogheda. As other companies would benefit by the adoption of the same gauge they were to contribute to the cost, £19,246, of the alteration. The line to Lisburn was opened on August 12th, 1839; to Lurgan on November 8th, 1841; to Portadown in 1842; and to Armagh on March 1st, 1848.

The Dublin and Drogheda—6 Will. IV., c. 132, 1836—was a line between the points named and a branch to Howth. The former was opened on May 26th, 1844, and the branch on July 30th, 1846. From Drogheda to Portadown was built by the Dublin and Belfast Junction, and its last stage was completed on June 3rd, 1852.

The Great Leinster and Munster—1 Vic., c. 104, 1837—was a line from Dublin to Kilkenny, 73 miles. Before it could be built the Drummond Commission report, already referred to, was issued, and as the route selected therein differed from that proposed by the Great Leinster and Munster Railway, the latter was limited to the route between Carlow and Kilkenny, as the Great Southern and Western—see below—would provide communication to Carlow from its line from Cherryville to Cork. The line was opened from Carlow to Bagnalstown on July 24th, 1848, and from Bagnalstown to Kilkenny on November 14th, 1850.

The Act—7 & 8 Vic., c. 100, 1844—sanctioning the Great Southern and Western, authorised the construction of a railway of the hitherto unprecedented length, for Ireland, of 122 miles 21 chains. It was to run from Dublin to Cashel, 96 miles, with a branch to Carlow, 26 miles. Extensions to Cork and from Portarlington to Tullamore were subsequently authorised. The line was opened thus:—Dublin to Cherryville and Carlow on August 10th, 1846; Cherryville to Maryborough, June 27th, 1847; Maryborough to Ballybrophy, September 1st, 1847; Ballybrophy to Thurles, March 1st, 1848; Thurles to Limerick Junction, July 3rd, 1848; Limerick Junction to Mallow, March 17th, 1849; Mallow to Cork, October 18th, 1849; Portarlington to Tullamore in 1854.

The first section of what was to become the Belfast and Northern Counties was the Belfast and Ballymena—8 & 9 Vic., c. 81, 1845. It had branches to Carrickfergus and Randalstown. All were opened on April 11th, 1848.

Communication between Dundalk and Enniskillen began with a section to Castleblaney, opened on February 15th, 1849, and was completed with that from Lisbellaw to Enniskillen on February 2nd, 1859. From Londonderry to Enniskillen began with the Londonderry to Strabane section, opened in March, 1848, and was completed with the Fintona to Enniskillen opened on September 19th, 1854.

The Midland Great Western was authorised by 8 & 9 Vic., c. 119, 1845, and under the charter the Royal Canal, which had cost £1,500,000, was purchased for £298,059. The railway was opened in the following order:—Dublin–Enfield, June 28th, 1847; Enfield–Kinnegad, December 26th, 1847; Kinnegad–Mullingar, October 2nd, 1848; Mullingar–Galway, August 1st, 1851; Mullingar–Longford, November 8th, 1855. A branch off the Longford line at Inny Junction to Cavan was opened on February 8th, 1856. The Cork and Bandon was opened from Bandon to Ballinhassig on August 1st, 1849, and into Cork on December 8th, 1851.

The Waterford and Limerick was brought into use as follows:—Limerick–Tipperary, May 9th, 1848; Tipperary–Clonmel, May 1st, 1852; Clonmel–Fiddown, April 4th, 1853; Fiddown to a junction at Dunkith with the Waterford and Kilkenny. The first stage of the Belfast and County Down, 9 & 10 Vic., c. 87, was opened on June 26th, 1846, and, like the Maryport and Carlisle in England, has never absorbed or been absorbed by any other company. The railway ran from Belfast to Downpatrick, and, with branches, was opened from Belfast to Holywood on August 2nd, 1848; from Belfast to Newtownards on August 6th, 1850; Comber to Crossgar and the Ballynahinch branch on September 10th, 1858; Crossgar to Downpatrick on March 23rd, 1859. It had one great disappointment—it had hoped to enjoy the benefits of the short sea distance from Portpatrick to Donaghadee. The harbour at the former place proved, however, to be unsuitable, and Stranraer to Larne was chosen instead. The Cork, Blackrock and Passage was opened between Cork and Passage on June 8th, 1850.

The Waterford, Wexford, Wicklow and Dublin Railway Company was authorised by 9 & 10 Vic., c. 208, 1846, to make a line from the Dublin and Kingstown to Waterford, and to lease the Dublin and Kingstown Railway. By 11 & 12 Vic., c. 29, the South Wales Railway Company was authorised to subscribe £250,000 towards the undertaking. This action was taken in view of a proposed steamship service between Fishguard and Wexford. The line between Dublin and Bray *vid* Dundrum was completed on July 10th, 1854, and that between Bray and Wicklow on October 30th, 1855.

The Institution of Petroleum Technologists.—The Institution's scholarship, granted to a student member of the Institution, who is completing the petroleum technology course at Birmingham University, has been awarded to Mr. Geoffrey Cotton.

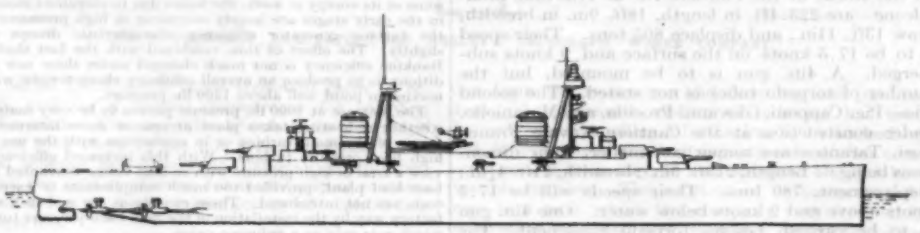
New Italian Warships.

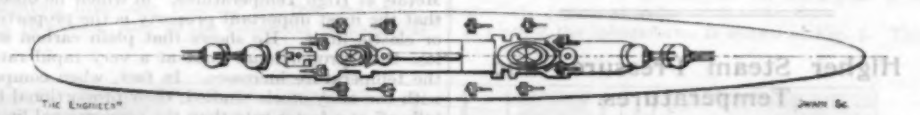
For many years before the war Italian naval policy was directed to the maintenance of the balance of power in the Adriatic. For this reason the strength of the Austro-Hungarian Fleet was the standard by which Italy measured her own requirements. But with the fall of the Dual Monarchy, and its elimination as a factor in the naval situation, Italian strategists are turning their gaze to the broader waters of the Mediterranean. At the Washington Conference three years ago Italy was allotted a ratio of capital ship tonnage equal to that of France; but in neither country is any disposition shown to embark on the construction of heavy ships. It is to the cruiser of high speed, the well-armed destroyer, and the submarine, acting in conjunction with powerful air forces, that both States look for the decisive blow to be struck in a future Mediterranean campaign. So far as can be gathered, they have not entirely lost faith in the battleship as a weapon of oceanic warfare; but for operations in narrow seas they hold—not unreasonably, perhaps—the lighter and speedier craft to be preferable. This doctrine is reflected in the building programmes on which they are now engaged. The French programme has already been dealt with in these columns. The Italian scheme is more limited in scope, but it is plain from official utterances in Rome that naval construction on a larger scale will be undertaken when the national finances permit. The number and type of vessels now authorised and the years in which they are to be laid down are as follows:—

1923–24	2 cruisers, 4 destroyers, 4 submarines
1924–25	2 cruisers, 4 destroyers, 4 submarines
1925–26	4 destroyers, 4 submarines
1926–27	4 destroyers, 4 submarines
1927–28	1 cruiser, 4 destroyers, 4 submarines

In addition, a number of minelayers and other auxiliaries are provided for.

All the vessels of the 1923–24 programme are now on the stocks, and we are indebted to the Royal Ministry of Marine, in Rome, for particulars of their design. Of special interest are the two cruisers,





NEW ITALIAN CRUISERS TRENTO AND TRIESTE

Trento and Trieste, the first of which is being built by Orlando, at Leghorn, and the second by the Stabilimento Tecnico Triestino, at Trieste. They are the first cruisers designed within the limitations of the Washington Treaty as to displacement and armament, of which the dimensions and other features have been disclosed. Many ships of the same generic type are being built elsewhere—five in this country, two in France, and four in Japan—but little is known of them beyond the fact that they will displace 10,000 tons. We believe, therefore, that the following description of the new Italian cruisers will be read with more than ordinary interest.

Length on water line	640ft. 9in.
Length between perpendiculars ..	615ft. 7in.
Breadth, maximum	67ft. 6in.
Draught, mean	18ft. 10¼in.
Standard displacement	10,160 tons (metric)
Displacement on trials	10,980 tons (metric)
Speed	35 knots
Armament	Eight 8in. 50-cal. guns; twelve 4in., 46-cal. A.A. guns; eight torpedo tubes in pairs

Perhaps the most striking feature of the ships is their great length, having regard to their comparatively small tonnage. They are nearly 36ft. longer than our cruisers of the "Raleigh" Class, which displace 9750 tons, and are as long overall as our battleships of the "Queen Elizabeth" class. Particulars of their machinery are lacking, but to attain a speed of 35 knots the engines will have to develop at least 110,000 shaft horse-power, or 27,500 shaft horse-power per shaft. Their armour will doubtless be of the lightest, and it is uncertain whether bulges are to be fitted. The main armament of eight 8in. guns is to be mounted in four barbettes, two at each end of the ship. Twelve 4in. guns will form the secondary battery. These will have high-angle mountings, but will also be available for horizontal fire against surface targets. No other warship built up to now carries such a formidable armament of anti-aircraft guns, though the growing menace of air

attack must soon compel designers to pay closer attention to this item of offensive equipment. The disposition of the twelve high-angle guns, as also of the main armament, is shown in the official diagrams we reproduce. Two aeroplanes will be carried. They will be launched by the "catapult," which is seen just forward of the main mast. The four pairs of torpedo tubes will be mounted above water, in accordance with a practice which of late years has become almost universal, the submerged tube having fallen into disfavour for ships of great speed. Good seagoing qualities should be assured by the lofty freeboard, and the high command of the guns ought to enable them to be fought effectively in almost any weather. The general design impresses us as an excellent one, though it will probably be found that the scantlings have been kept rather light and protection reduced to a minimum in order to gain the high speed aimed at. The ships embody several of the requirements which Admiral of the Fleet Sir Doveton Sturdee, in a lecture on April 9th this year, laid down as desirable for future cruisers of the British Navy, viz., good seakeeping attributes —"probably the most important"—guns mounted as to height and manner as to be capable of effective use in most conditions of weather; a higher maximum speed than that of possible enemy battleships; powerful armament; ability to carry and launch two aeroplanes; and anti-aircraft guns.

Eight of the new destroyers are already under construction—Borea, Espero, Ostro, and Zeffiro, by Ansaldo, at Sestri Ponente; Aquilone and Turbine, by Odero, at Sestri Ponente; Euro and Nembo, by the Società Esercizio Bacini, Riva Trigoso. The leading particulars of these boats are as follows:—Length, 305ft. 9in.; breadth, 30ft. 2in.; draught, 10ft. 8in.; displacement, 1355 tons metric; speed, 36 knots. Armament:—Four 4.7in. guns, six torpedo tubes. All are to be ready for trials by the close of 1926. The type, it will be observed, is very similar to that of our "Modified Admiralty W" class of destroyers.

The submarines in hand number six, two different designs being represented. The first three—Giovanni Bausan, Marcantonio Colonna, and Vettor Pisani, on the stocks at the Cantiere Naval Triestino, Monfalcone—are 223.1ft. in length, 18ft. 9in. in breadth, draw 13ft. 11in., and displace 805 tons. Their speed is to be 17.5 knots on the surface and 9 knots submerged. A 4in. gun is to be mounted, but the number of torpedo tubes is not stated. The second trio—Pier Capponi, Giovanni Procida, and Masaniello, under construction at the Cantiere Navale Franco Tosi, Taranto—are somewhat smaller, their dimensions being:—Length, 213ft. 3in.; breadth, 21ft. 4½in.; displacement, 780 tons. Their speeds will be 17.5 knots above and 9 knots below water. One 4in. gun is to be carried, besides torpedo armament. The contracts call for delivery of all six boats before the end of 1926.

Higher Steam Pressures and Temperatures.

We have received from the National Electric Light Association of New York a number of reports made by the Prime Movers Committee to the Convention of 1923–24. These reports are remarkable from the fact that they not only contain what may be described as general editorial remarks—by the Committee—papers by experts and investigators, and *précis* of literature, but because they include brief statements by operating companies and by manufacturers. Amongst them we find one of exceptional interest on the use of high steam pressures and steam temperatures. It observes that "to-day when higher pressures are spoken of, pressures of 300 lb. to 400 lb. are no longer referred to, as was the case not many years ago; pressures of this magnitude have become standard pressures, and the field covered by the term 'higher pressures' has been advanced to pressures over 500 lb." As a result the situation has increased in complexity, for it is now necessary to extract all the steam from the turbine, re-heat it and return it to the turbine. Moreover, steam must be taken from the turbine at various points to heat the feed water, whilst in order to increase efficiency and decrease erosion moisture must be removed from the steam at the lower stages. Hence, the plant becomes more complex, and it is still a matter of conjecture whether such plants will have desirable operating flexibility. For base load plants the problem is relatively simple, but for other plants "the adoption of pressures much in excess of 350 lb. with the accompanying auxiliaries required to attain the higher efficiencies striven for, may result in service difficulties or variable quality of service, due to the flexible operating characteristics of such a plant." Yet the Committee feels that in a few years these difficulties will be overcome, and that a wider application of higher pressures to plants not falling within the category of base-load plants will be realised.

From the statements made by operating companies on the general question, we take the following:—The Detroit Edison Company, when designing the Trenton Channel plant, decided that the steam temperature must not exceed 725 deg. Fah., and a pressure of 415 lb. per square inch was fixed by the boilermakers as the highest that could be used with a boiler drum of about 48in. diameter. On the other hand the Electric Bond and Share Company gives the following reasons for selecting a plant to work at 350 lb. instead of 525 lb.:—

(1) Assuming that there are no unforeseen difficulties or expenditures called for by the higher pressure, a 525 lb. plant would cost about 10 per cent. more than a 350 lb., which would increase fixed charges on energy output by at least 0.25 mills per kilowatt-hour. A 525 lb. plant would save only 6 to 7 per cent. in fuel as compared with a 350 lb., which would mean about 0.2 mills per kilowatt-hour, or less than the additional fixed charges.

(2) The 525 lb. pressure involves a new development, with some uncertainty as to proper design and as to reliable and low cost operation. With the 525 lb. it is necessary to re-heat the steam, carrying it for that purpose from an interstage opening of the turbine back to the boiler-room and again back to the turbine; this involves large and expensive piping and the details of design and operation have not as yet been satisfactorily worked out.

(3) The 525 lb. turbine seems to be primarily a base load machine, the method of operation sometimes recommended by the manufacturer being to change the steam pressure with the load; this procedure apparently disturbs bleeding, re-heating and general turbine conditions as little as possible. It would be difficult to maintain a satisfactorily constant load on a machine of this size in connection with the power station under consideration.

(4) The lower pressure plant would be simpler in general design and in operation.

The Edison Electric Illuminating Company, of Boston, refers in its report to its station at Weymouth, which will contain two 32,000-kilowatt turbines, driven by steam at 375 lb., with a total temperature of 700 deg. Fah., and one 2500-kilowatt turbine which will take steam of 1200 lb. and exhaust into the 375 lb. system. The company is of opinion that the effect of temperature upon materials limits steam temperatures to 725 deg. Fah. With regard to efficiency, the company says:—

While the turbine generator efficiency has a falling characteristic under these conditions, the Rankine efficiency has a rising characteristic. These two components produce an overall efficiency characteristic which rises to its highest point of efficiency at a pressure of 600 lb. When capital costs are taken into consideration the pressure point of highest efficiency is reduced to 375 lb. For this reason the main part of the installation is designed for 375 lb. pressure and future extensions of the plant can be made on this basis without undue complication if it later appears desirable.

When the steam, however, is re-heated after having spent some of its energy in work, the losses due to entrained moisture in the early stages are largely overcome at high pressures and the turbine generator efficiency characteristic droops only slightly. The effect of this, combined with the fact that the Rankine efficiency is not much changed under these new conditions, is to produce an overall efficiency characteristic with a maximum point well above 1200 lb. pressure.

The increase at 1000 lb. pressure proves to be very material, whether re-heating takes place at one or more intermediate stages of the main turbine or in connection with the use of a high back-pressure turbine. With this increased efficiency in view a trial of high pressure with re-heat seems warranted for a base load plant, provided too much complication or excessive costs are not introduced. These conditions are met in a satisfactory way by the installation of the high back-pressure turbine which acts only as a reducing valve.

Professor A. E. White, University of Michigan, presents a progress report on the "Properties of Metals at High Temperatures," in which he observes that the most important property is the proportional or elastic limit. He shows that plain carbon steels lose their proportional limit at a very rapid rate as the temperature increases. In fact, when compared with the alloy steels studied, their proportional limit falls off at a faster rate than the proportional limit of any of the alloy steels. The addition of manganese and nickel does not seem to assist the steels materially in maintaining a high proportional limit when the steels in question are subjected to high temperatures. Chromium seems to be of decided value. The drop in the proportional limit as temperature rises is much less in the chromium steels than in any of the other groups for which data are here submitted. This condition is true for the straight chromium, chromium molybdenum, and chromium vanadium steels. These steels, therefore, seem to possess valuable properties for high temperature requirements.

On this part of the subject the manufacturers have a good deal to say. The Allis-Chalmers Manufacturing Company agrees that 725 deg. Fah. appears to be the limiting temperature at present, and it alludes to designs for 3000 to 4000-kilowatt machines using steam at about 1700 lb. pressure. Standard machines of 10,000 kilowatts and larger are now being proportioned for 400 lb. gauge pressure, with a temperature of 725 deg. Fah. The Babcock and Wilcox Company reports that it has supplied 256,000 horse-power of boilers for 350 lb. and over, and that boilers aggregating 40,000 horse-power are being made for 650 lb. The highest pressure for which it is building is 1200 lb., and in connection with these boilers it writes:—"Few appreciate what it means to design and build high-pressure boilers of this sort for power plant conditions. It is easy to build a small boiler for any desired working pressure, but when it comes to building a unit to give proper service in evaporating 150,000 lb. of water into steam, it is a much more difficult proposition. The steel used in the drum conforms closely to that specified in the A.S.M.E. code for boiler plate, although of a somewhat higher minimum tensile strength, and the maximum allowable stress is taken at 11,000 lb., thereby corresponding to the figure specified in the code for a steel of a lower tensile strength and giving a higher margin of safety."

The Chapman Valve Manufacturing Company discusses the question from another aspect. It says:

The extremely high temperature of superheated steam changes the physical characteristics of various alloys, but until recently the effect of such high temperatures was largely a matter of guesswork.

Bronze rings and later nickel-bronze trimmings were used, but with unsatisfactory results, because the bronze rings expanding at a greater rate than the steel body, caused a great compressive force to act along the ring area, in turn resulting in loose seat rings, which are dangerous. It was a matter of considerable research to find an alloy by which this difficulty could be overcome.

Nickel-copper alloys were found to have the nearest coefficient of expansion to steel of any suitable alloy, and it therefore became a necessity for the Chapman Valve Manufacturing Company to determine the most suitable alloy for its valves.

Monel metal at that time was found to be an alloy suitable for this condition, because it was a natural alloy of nickel and copper and the results of tests both physical and chemical had proved its value. Its use, however, in cast form was limited on account of a number of difficulties involved, and discouraging to the utmost on account of the prevalence of imperfections and porosity which were not discovered until the castings, machined, finished and assembled in valves, were tested under hydrostatic pressure, when the porosity would be revealed.

It therefore again became necessary for the company through its research department to develop an alloy having all the properties of monel metal without its bad features, and it was after years of metallurgical research that an alloy was developed for use in valves that had all the required properties, such as low coefficient of expansion, physical properties near to those of steel, and especially good properties at elevated temperatures without the various sources of defects that existed in monel metal.

It was found that this alloy had properties more valuable than originally contemplated, which brought it into a field where formerly unsatisfactory results were obtained.

This alloy, which is known as Davis metal, is in itself a nickel copper alloy, and has recently been added to the Chapman line after years of successful tests both in laboratory and in field service, as to its non-corroding properties, its capacity to resist the erosive action of hot gases, its low coefficient of expansion, its low heat conductivity, its high strength and elastic limit especially at elevated temperatures, and its bright finish and ability to resist oxidation.

It gives the following table showing the relative properties of Monel and Davis metals:—

Comparison of Physical Properties of Davis Metal and Monel Metal.

	Davis metal.	Monel metal.
Elastic limit, lb. per sq. in.	40,000	32,000
Elastic limit, 1000 deg. Fah., lb. per sq. in.	35,400	25,550
Ultimate strength, lb. per sq. in.	67,000	63,000
Ultimate strength, 1000 deg. Fah., lb. per sq. in.	60,300	49,500
Coefficient of expansion, per deg. Fah.	0.00000790	0.00000870
Thermal conductivity	1/13 that of copper	1/13 that of copper
Specific gravity	8.751	8.836
Weight per cubic inch, lb.	0.316	0.319
Toughness	Both can be bent nearly double	
Hardness	120 Brinell	110 Brinell
Rigidity	Both equal to steel	
Modulus of elasticity	24,000,000	22,000,000 to 23,000,000
Melting point, deg. Fah.	2,450	2,480

The Heine Boiler Company holds the view that for some time to come 400 lb. pressure with a temperature limit of about 650 deg. Fah., will prevail as the use of higher pressures "involves exceedingly high first cost of installation and greatly increased maintenance and care in operation." It feels sure that for pressures from 600 lb. upwards a boiler entirely different from the present generally accepted types must be developed. "With relatively thin plates the material is subjected only to simple tension, but in the thicker plates the so-called hoop-tension becomes of major importance." The Power Speciality Company says it believes that bleeding turbines for heating feed water has distinct and unquestionable advantages, but that it can very easily be carried beyond the point of commercial worth, and that before it will be profitable to carry bleeding much beyond the point required to give water temperatures of 200 deg. for 400 lb. pressure, the efficiencies of air heaters will have to be much higher than they are at present and the cost less.

Theoretically, with an infinite series of bleedings, and starting with 400 lb. pressure and 700 deg. throttle temperature, the increase in efficiency from bleeding at 200 deg. to bleeding at 300 deg. is approximately 3.5 per cent. In an actual installation with a limited number of bleeding stages and with the efficiency of the turbine taken into account, the increased efficiency realised cannot be much more than 2.5 per cent. If, therefore, the power produced from a boiler absorbing a given amount of heat with the feed water entering at 200 deg. is taken as 100, the power produced with the feed water heated to 300 deg. would be 102.5. If the feed water were heated to 300 deg. by an economiser, the power produced would be 109. Consequently an air heater, to equal the economiser installation, would have to heat air so as to effect an increase in steam production of approximately 6½ per cent. This would correspond to a reduction of the flue gas temperature passing through the heater of roughly 200 deg. Since modern installations are showing a CO_2 loss of at least 2 per cent. between the furnace and the outlet of the boiler, and since, further, the weight of the flue gases is increased over the weight of the air by the weight of the fuel burned, it seems impossible to anticipate that the weight of the air heated can exceed 80 per cent. of the weight of the gases cooled, and consequently to effect the cooling of 200 deg. in the flue gases the air must be heated at least 250 deg., which corresponds to a temperature of the air entering the furnace of approximately 350 deg. An air heater for this service must consequently be compared with an economiser for a temperature rise of from 200 deg. to 300 deg., and as matters now stand the air heater would be the more expensive piece of apparatus, particularly if the economiser is given credit for the increase in the peak load capacity it gives to the boiler plant as represented by the difference between 109 and 102.5.

The Westinghouse Electric and Manufacturing Company says—:

Unless means are available to utilise high pressure in turbine elements with nearly as high an engine efficiency as with lower pressures, the use of steam at more than 400 lb. or 500 lb. pressure cannot be justified.

It is believed that good efficiency may be secured at the high-pressure end of a turbine, but unless a large proportion of the moisture may be extracted from the low pressure end, pressures beyond 300 lb. or 400 lb. must be accompanied with re-heating.

The use of re-heaters will necessitate the use of a special governing device to control the re-admission of steam to the turbine and prevent overspeeding in case of sudden reduction of load.

Steam entering the turbine at high pressure but with limited

temperature will become wet before reaching the exhaust. As a consequence of the presence of moisture the turbine performance will be adversely affected and the blade deterioration increased. By re-heating the steam at some stage of its expansion the formation of moisture is prevented, a dry cycle is obtained and performance thereby improved. The most favoured method of re-heating is to pass the steam after partial expansion in the turbine back to heater elements installed in the boiler setting wherein its temperature is raised to approximately its initial amount. The steam then re-enters the turbine at a lower stage and is expanded to its final temperature.

With the steam re-heated there is a possibility of loss in economy due to an increase of heat discharged to the condenser. The pressure and temperature to which the steam is to be re-heated are the factors which determine the gain which may be secured by re-heating. This gain may be offset by the increased heat that is rejected to the condenser in the exhaust, which under certain conditions may result in actual loss in overall efficiency. It is felt that in order to obtain the greatest overall improvement the steam should be re-heated at a stage where the heat drop is about one-third of the total adiabatic heat drop. For units of more than one cylinder the high-pressure turbine is designed to exhaust the steam at the pressure which will allow the maximum re-heat gain, except in the case of a high-pressure turbine added to an existing station and exhausting at a pressure corresponding with the inlet pressure of the old turbine, under which circumstances the re-heat pressure will be the same as the inlet pressure of the old turbines.

From this survey of the whole subject it would appear that American engineers are not yet generally prepared to accept pressures much in excess of 400 lb., although higher pressures are being employed in several instances. The temperature limit is more definite, and it is clear that until some new metal is introduced it is in the neighbourhood of 700 deg. Fah. Re-heating and bleeding for feed heating are standard practice for high-pressure plants.

Research Laboratories at a Cable Works.

THE value of research in the electrical industry is a matter to which we have often alluded. There has been a tendency, we fear, for electrical manufacturers to go on working on well-established lines without taking very drastic steps to ascertain whether their processes can be improved or whether their products conform in all respects with modern requirements. To-day, however, firms that neglect research run a grave risk of being outdone by their competitors, who have recognised that progress has changed conditions, and that things that they have been in the habit of producing will not necessarily serve in the future. The ever increasing demand for electricity is giving rise to problems which did not present themselves in the past, and firms that do not attempt to grapple with those problems cannot hope to survive.

If electricity is to play the part which has been allotted to it, no pains must be spared to cheapen and improve electrical equipment, especially that associated with transmission and distribution, for it is an established fact that cheap electricity is not solely dependent upon the economical operation of the power house. The growth of the electricity supply business has necessitated the adoption of pressures which were not dreamt of in the past. In time to come other radical alterations will in all probability be necessary, and it behoves all who desire to see the electrical industry progress to endeavour to discover what can be done to improve our present methods.

It always gives us pleasure to hear of firms that have made arrangements to undertake serious research, and it is indeed satisfactory to discover that the number of firms that are giving attention to this matter is increasing. The opening of the large electrical laboratories at Wembley in 1923 was, in our opinion, an event of paramount importance, for up to that time there were no electrical research laboratories in this country comparable with those belonging to some of the large electrical firms in America. We are still behind other countries in this respect, but the conditions, we are glad to find, are undoubtedly improving. To the steadily increasing number of electrical firms that are paying serious attention to research, W. T. Henley's Telegraph Works Company, Limited, of Gravesend, Kent, can now be added. Research is no new thing to this particular concern, for cable making has always presented a number of interesting problems which can only be solved by investigation, but within the past few years conditions in the electrical industry have called for a much more thorough form of research, and for a special department for carrying out the work. Consequently about three years ago the firm took steps to get out a new and much improved scheme, and a very fine laboratory equipped with all the best appliances for investigating matters in connection with the manufacture of cables has been erected.

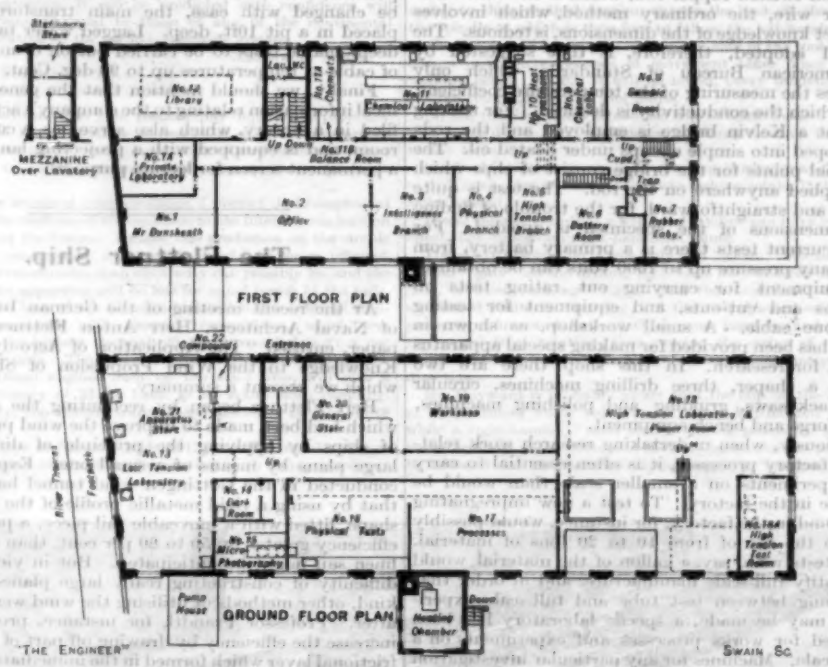


FIG. 1—RESEARCH LABORATORY OF HENLEY'S TELEGRAPH WORKS COMPANY

The activities of the department are so divergent that it is difficult to summarise them, but roughly speaking, most of the time of the staff is taken up in investigating questions relating to raw materials, factory processes, and in the collection of technical information. High-class cables obviously cannot be produced without high-class raw materials, such as copper, paper, oil and rubber, and consequently to a large extent the laboratory apparatus is designed for testing the quality of materials and for finding new and better materials than those which are commonly employed. Considerable attention is now paid in the laboratories to the details of processes, and there is complete co-ordination between the research and works staff. As far as possible, however, the company aims at making production a routine procedure, experimental work being confined to the research department. Mr. Percy Dunsheath, who is at the head of the laboratories, contends, and most engineers will, we think, be in agreement with him, that by confining research work to a special department, considerable economies are secured, for not only is the production work left undisturbed by experimenters, but men who are specially trained to observe the connection between cause and effect, and with time to watch all the factors, can carry out an investigation much more satisfactorily than foremen and others who are connected with the factory and who have little spare time at their disposal to investigate special problems.

Besides the work of testing materials and investigating processes, another important function of the laboratories is the compilation of technical information from the researches and from various publications. An elaborate system of indexing has been devised, which enables information to be looked up and disseminated to other departments of the company and, if necessary, to customers, in the quickest possible manner. The solution of customers' problems is a task which the company very frequently undertakes, and the service, which covers problems of a very varied kind, is highly appreciated. Whilst realising the value of academic research, it is considered better to concentrate on work that is of immediate practical value.

A plan of the laboratories is shown in Fig. 1. The building is a two-storey steel and brick structure with a ferro-concrete floor and a flat roof, the total area available for all purposes being 14,000 square feet. The power supply for the laboratories is brought into the building at a pressure of 6600 volts and with the aid of a rotary converter and a flexible arrangement of switchgear and circuits the various laboratories are supplied with three-phase current at a pressure of 440 volts and direct current at pressures of 250 and 500 volts, whilst from a 110-volt, 800-ampère-hour battery any pressure between 2 and 110 volts can be obtained in any room.

FIG. 2—EXPERIMENTAL WORKSHOP

FIG. 3—MAIN POWER PLANT

The low-tension laboratory—a view of which is given in Fig. 6 on page 614—contains four galvanometer sets, the instruments standing on brick pedestals carried down 6ft. to a chalk foundation. There is a

dielectric resistance testing set for cables, &c., a special dielectric resistance testing set for oil and compounds, a rotary viscometer, a sphere viscometer, an electric breakdown testing apparatus for pressures up to 50,000 volts, and a low resistance bridge. Dielectric resistance, breakdown and viscosity tests are made on every consignment of the impregnating compounds which reach the works, and for each of these tests special apparatus has been devised.

The method adopted for measuring the conductivity of copper is of special interest. Because of the difficulty of obtaining the correct dimensions of a bent and twisted copper rod, which is the raw material for wire, the ordinary method, which involves an exact knowledge of the dimensions, is tedious. The method adopted, therefore, is that suggested by the American Bureau of Standards, which only involves the measuring of the temperature coefficient, from which the conductivity is deduced. For making the test a Kelvin bridge is employed and the rods are slipped into simple clamps under heated oil. The potential points for the bridge consist of clips which are applied anywhere on the rod. The test is quite simple and straightforward, for the trouble of finding the dimensions of the specimen is avoided. For direct-current tests there is a primary battery, from which any pressure up to 1000 volts can be obtained, an equipment for carrying out rating tests on switches and cut-outs, and equipment for testing telephone cable. A small workshop, as shown in Fig. 2, has been provided for making special apparatus needed for research. In this shop there are two lathes, a shaper, three drilling machines, circular and hack saws, grinding and polishing machines, and a forge and bench equipment.

Obviously, when undertaking research work relating to factory processes, it is often essential to carry out experiments on a smaller scale than would be possible in the factory. To test a new impregnating compound in the factory, for instance, would possibly involve the use of from 10 to 20 tons of material. Small tests with, say, a gallon of the material, would not justify full-scale manufacture, and in order that something between test tube and full-scale experiments may be made, a special laboratory has been provided for works processes and experiments on a small scale. Machines for any particular investigation that may be on hand are brought into this laboratory as required. In this laboratory a simple hydraulic tester has been installed for various kinds of tension and compression tests, and with its aid a longitudinal pull of 100 tons can be applied to a piece of submarine cable. Two other machines worthy of mention are the Schopper tensile tester and a paper tearer. The former, which is a standard machine for testing cottons, rubber, twine and fine wires, has recently been used for applying compression tests to tennis balls, which are made by the company in a separate factory adjoining the cable factory. The tearing tester, which is a very simple machine and scarcely calls for description, is used to determine whether a tearing test is a better criterion of the qualities of a paper than the tensile strength test. In the same room a piece of apparatus has been installed for demonstrating the action of fibres on the breakdown of oils. This apparatus shows very clearly how the presence of fibres in oil may produce breakdown. The fibres collect between two spheres subjected to a high potential. They come together in the electrostatic field, and the good insulation afforded by the oil in the gap is ultimately destroyed.

The microscopic examination of materials used in the manufacture of cables is, of course, of considerable importance, and it is not surprising to find very elaborate microscopic and photographic equipments in these new laboratories. An expert microscopist is kept constantly employed examining and recording the micro-structures of papers, lead, copper, and so forth. In connection with the examination of lead sheaths, the surface is polished and etched with special reagents, and the crystal formation is thus brought out very clearly. In the chemical laboratory —shown in Fig. 9 on page 614—the work consists of acceptance tests on raw materials, control tests on materials during manufacture, and chemical examinations required in carrying out research investigations. In the lay-out of these laboratories one or two special features have been introduced. The reagent rack, for instance, has been run parallel to the main bench, and between that bench and a subsidiary bench, so as to be accessible on both sides. A small laboratory with furnaces of various kinds has been provided for heat treatment. In the rubber laboratory—shown in Fig. 5 on page 614—there are experimental rubber rolls, a vulcaniser and the accessories necessary for making up experimental batches of rubber or gutta-percha test samples under controlled conditions.

The high-tension laboratory—shown in Fig. 7 on page 614—is one of the most interesting departments from the point of view of electrical engineers. It is equipped with a complete modern testing plant for the measurement of dielectric losses and for the application of high-voltage tests to finished lengths of cable. A 225-kilovolt-ampère three-phase 550-volt motor alternator, operating in conjunction with three regulating transformers, supplies the primaries of three 500/125,000-volt single-phase testing transformers, which are insulated for 250 volts to earth, so that by suitable grouping a three-phase test at 210,000 volts, or a single-phase test, 375,000 volts, can be carried out. In the design of this plant several novel features have been introduced. The voltage regulator of the high-tension transformer, for instance, is automatic in action, the driving motor being controlled by a series of push buttons in the instrument room. Experience has shown that in carrying out breakdown tests the actual rate of the increase in voltage is of great importance, and in designing this new plant arrangements were made to enable the voltage to be raised at four different rates. In order to economise head room as much as possible, and to enable the terminal connections to be changed with ease, the main transformers are placed in a pit 10ft. deep. Lagged water tanks, 8ft. deep, enable tests to be carried out on drum lengths of cable at temperatures up to 90 deg. Cent.

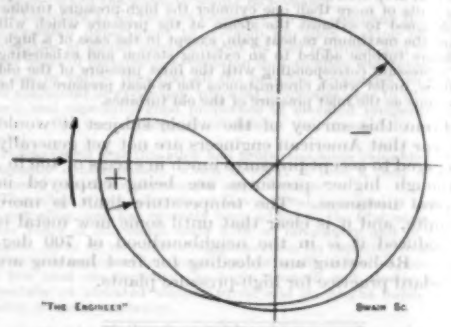
Finally, we should mention that the general technical information relating to the company's activities is filed in a library, which also serves as a conference room, and is equipped with a projecting lantern and a permanent screen for lecture purposes.

The Flettner Ship.

At the recent meeting of the German Institution of Naval Architects, Herr Anton Flettner read a paper, entitled "The Application of Aero-dynamical Knowledge to the Wind Propulsion of Ships," of which we present a summary.

Herr Flettner began by recounting the attempts which had been made to improve the wind propulsion of ships by applying the principle of directing a large plane by means of a small one. Experiments conducted in the Göttingen wind tunnel had shown that by using a rigid metallic profile of the requisite shape, fitted with a moveable tail piece, a propulsive efficiency greater by 50 to 60 per cent. than that of a linen sail might be anticipated. But in view of the difficulty of constructing really large planes of that kind, other methods of utilising the wind were sought after. Professor Prandtl, for instance, proposed to increase the efficiency by drawing off part of the inert frictional layer which formed in the immediate vicinity of the plane; but there, too, difficulties of construction were met with, having regard to the behaviour of the planes when a sudden storm or hurricane arose. The possibility was next considered of artificially creating circulatory air currents through the agency of symmetrical planes fitted to the ship rigidly and immovably, the ship being steered by varying the directional flow of the artificial currents. The idea of using as sails rigid planes, round which a skin or membrane revolved, was also considered, particularly after studying Professor Föttinger's work, "New Principles for the Theoretical and Experimental Treatment of the Propeller Problem"; but in view of the necessity for having mechanical power for that purpose, the idea was not at that time proceeded with. Meanwhile, investigations had been set on foot at the Göttingen Experimental Station to determine the strength and nature of the currents which a rotating cylinder encountered in a lateral wind. These currents had been the subject of a report in 1853 by Professor Magnus, of Berlin, in his work "On the Deflection of Projectiles." He had discovered that a projectile set spinning by discharge from a rifle barrel became subject to the influence of a side wind immediately its axis ceased to move exactly in the tangent of the trajectory. The effect of the rotation was to give this side wind a transverse driving force—that was, towards the side on which the relative speed of the wind and the circumferential speed were in the same direction. Similar phenomena were discussed by Lord Rayleigh in his essay on "The Irregular Flight of a Tennis Ball." Moreover, some ten years earlier, the forces in question had been measured by Lafay, in Paris. These observations were repeated at Göttingen, and the results there obtained induced the author to apply the "Magnus effect" to the wind propulsion of ships. After registering his patent, he made experiments on the Wannsee with a small model ship, equipped with a cylinder, 40 cm. high and 15 cm. in diameter, operated by clockwork. These experiments encouraged further tests, and searching investigation of the "Magnus effect" was made at the cost of the Flettner Company. The "Magnus effect" is explained by the fact that a wind blowing against a motionless cylinder and symmetrically playing about it, is so influenced when the cylinder begins to rotate that the friction of the cylinder surface draws the wind with it. Hence, there follows a deflection of the off-flowing wind governed by the direction of rotation; and in the vicinity of the cylinder surface, where the direction of the wind and that of rotation are in accord, reduction of pressure results, while increase of pressure is set up in the reverse direction. The sphere of reduction exceeds that of increase very considerably.

A phenomenon observable in all phases of the technique of wind currents is equally evident here, namely, that the low-pressure side is by far the more important, and special attention must, therefore, be paid to the possibility of improving this decrease of pressure. The pressure distribution—shown in the sketch—occurs when the ratio of wind velocity to circumferential speed is between 1 : 3 and 1 : 4. The distribution of pressure indicates approximately the results to be expected from the direction and force of the propulsive power derived from the Magnus effect when it is applied to the cylinder, and, therefore, to the ship on which the cylinder is erected. When determining the force of the driving power it was found to be very important to fit discs at each end of the experimental cylinder in order to prevent the counter pressure from escaping past the ends without having exerted its power. Such discs were accordingly fitted to the rotors of the Buckau —see the illustration in our last issue. It was further ascertained that the driving power was dependent in very large measure on the relation between circumferential speed and wind velocity. When this



MAGNUS EFFECT

relation is unity, wind pressure and propulsive energy are equal; when it is two, the driving power is five times greater than the wind pressure, and it becomes nine times as great when the circumferential speed undergoes a four-fold increase of the wind speed; but from this point onward the ratio remains practically unaltered. Consequently, not even a hurricane would add much to the power of propulsion, for in that case the ratio between circumferential speed and wind velocity would approach unity. The driving power would thus be less even than that exerted by the masts and rigging of a sailing ship in a hurricane, while, on the other hand, the pressure exerted against the motionless cylinder would be considerably lower than the driving power. This result would have a most favourable effect on the stability and general behaviour of the rotor ship in a storm.

Compared with the propulsive power of ordinary sails, that of the Flettner cylinder is about eight times as great, so that the surface area of the two cylinders need be only one-eighth that of a sail of corresponding value. Furthermore, the reduction in driving power caused by a change in the direction of the wind is much less with the cylinder than with sails. The Buckau, for example, can sail within about 30 deg. of the wind.

The reconstruction of the Buckau as a rotor ship was undertaken at the Germania yard, Kiel. The two driving towers, 15.6 m. in height and 2.8 m. in diameter, have covers of 1 mm. steel plate. Each is supported on a stout pivot, extending 1.5 m. below and 13 m. above the deck. They are operated by two reversible direct-current motors of 11 kilowatt, 220 volts, driven by a 45 horse-power Diesel engine. The stability of the ship was greatly improved by its reconstruction, for the heavy weights formerly carried high above deck level have gone, the built-in rotor towers being lighter and having a lower centre of gravity. The control system is remarkably simple. Hand wheels situated on the bridge control the direction and speed of rotation of both cylinders. When the forward tower ceases to revolve, the ship turns in the wind; tacking is effected by bringing the after tower to a standstill. To drive the ship ahead both towers are rotated clockwise from the windward side. When they are rotated in the opposite direction the ship goes astern. Turning and tacking manœuvres may be executed without causing the vessel to lose way—as she would do if under sail —for one of the towers still continues to drive her ahead.

Repeated trial trips have shown that the towers do not cause the ship to roll heavily, nor is their rotation affected by rolling or pitching movements. On the contrary, every expectation based on the experiments at Göttingen with this new method of wind propulsion has been fulfilled. It is, therefore, well adapted to serve as an auxiliary means of propulsion for mechanically-driven ships, since by turning to profitable account the power of the wind it enables a large saving in fuel to be effected, thus contributing to economy in the operation of shipping.

The paper was illustrated by a film, depicting various stages in the development of the rotor ship, experiments at the Göttingen and Hamburg experimental stations with cylinders turning in air and water, and scenes from the trial trips.

The pig iron output of Canada for the first three quarters of this year was 518,860 tons, and that of steel amounted to 581,711 tons.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE FUTURE OF THE LOCOMOTIVE.

Sir,—May I venture to say with what surprise and sorrow I have perused the extraordinarily worded editorial under the above title which appears in your issue of 14th inst. ?

Your digest of the situation will doubtless be read with great interest, appearing as it does in THE ENGINEER, probably the best known advocate of the normal steam locomotive. In particular, your wholesale denunciation of the British locomotive building industry must be grateful reading to continental engineers, and they must feel amply rewarded for their recent participation in the German Open-air Station Exhibition of what were, as regards novelties, practically untested locomotives.

The chief mechanical engineers of our railway companies need no apologist, and they are quite capable, should they care to do so, of answering from their point of view your diatribe.

We have not failed to note your special reference to our exhibit of a geared turbine-condensing locomotive, of which you say "no one knows anything of its value." We quite frankly admit that we deliberately elected to lose six months' valuable time, in which we might have put our engine through a series of experimental trials. We did so, owing to our anxiety to make an outstanding contribution to the British Empire Exhibition. It is only at the end of these six months that the German builders have put anything "on the road."

You refer to "The Rocket." It is interesting to recall that that engine was constructed with the prospect of winning a premium given by the Liverpool and Manchester Railway Company, with the further provision that the engine would become their property at a stated price, if satisfactory results were attained. The results were not merely a "Stephenson" win, but the world-wide awakening of railway progress. Where is the corresponding encouragement given by railway companies to-day to foster invention in the country that produced "The Rocket" ? The State Railways of the Continent are not averse to guaranteeing purchase of new types of locomotives—among them, probably, some of those to which you have so prominently referred.

This company in the past designed and built on its own initiative, and at its own cost, the first steam turbine-condensing electric locomotive, and a British syndicate produced a development of this turbine condensing electric locomotive (at—it is said—a cost of about £70,000), and now we have ourselves designed, built and exhibited a geared turbine condensing locomotive, and THE ENGINEER dismisses all these and other British efforts with the remark that we "have actually nothing to set in the balance against the Ljungström, the Zoelly and the Lomonossoff engines."

I can assure you the only question that occasionally arises in our minds in this connection is whether this company was justified in undertaking, without outside encouragement and support, such heavy expenditure in order to effect, if possible, radical thermal and mechanical improvements in the locomotive as at present operating the traffic on our railway systems.

I enclose a photograph of the elaborate testing plant which we have specially installed at our works for testing our geared turbine locomotive.

HUGH REID.

Glasgow, November 24th.

Sir,—Referring to your article on the "Future of the Locomotive," which appeared in your issue of the 14th inst., and particularly to the last paragraph calling attention, and rightly, too, to the small part which Great Britain is playing in the development of the locomotive. As one who has taken an active interest for some years in this branch of the transport problem, perhaps I may be permitted to offer a few remarks.

The slowness of the progress in this country is due principally to two reasons :—(1) The difficulty of obtaining financial support to carry out research ; and (2) to the apathy and, perhaps, to the inherent conservatism of locomotive engineers where departures from conventional lines are concerned.

The present-day system has held its position because of its simplicity and mechanical reliability, but development along the present lines is undoubtedly nearing its end and especially where larger powers and greater economy are desired.

Perhaps more research has been carried out in this country than is commonly supposed, and I would like to be allowed to correct your statement that "we have actually nothing to set against the Ljungström, the Zoelly and the Lomonossoff engines."

The Ramsay is perhaps the best known turbo-condensing locomotive which has been built in Britain, and much careful research and development, extending over a long period, has been carried out under the direction of the writer on this interesting machine.

The engine, obviously, can only be regarded as an experimental one, although its capacity for dealing with traffic under ordinary every-day conditions has been fully established.

The eminently satisfactory results and the valuable data obtained, which up to the present have not been published, have enabled designs of turbo-condensing engines of a greatly simplified character to be produced which, without being guilty of undue optimism, it can be predicted with confidence will give performances equal to those of any of the continental engines operating on the turbo-condensing system.

GEORGE F. JONES.

London, November 22nd.

Sir,—However much your readers may deplore the prophecy contained in the concluding sentences of your leading article on the subject above, their observation of current events must lead them to entire agreement with you as to its probable fulfilment.

In answer to one of your questions, I predict that compressed air will be the medium of transmission in the internal combustion locomotive of the future. I make this prediction on the simple basis that, compressed air properly used is a more efficient medium of transmission than electricity can possibly be, and the weight of the apparatus will be less for equal power at the rails.

Taking the case of the German-built main-line internal combustion locomotive with electric transmission, which you illustrated, the highest thermal efficiency recorded is 27.4 per cent. at the rails. The Diesel engine of that locomotive, like the other Diesel engines built by the same firm, will give a thermal efficiency of 35 per cent. at its crank shaft coupling. Consequently, the electric transmission efficiency is only 78.28 per cent.

In your issue of January 12th, 1912, you illustrated a design of an internal combustion locomotive with compressed air transmission that was claimed to have a transmission efficiency of over 100 per cent. Since that date a simpler and still more efficient method of using compressed air has been devised for locomotive purposes. The exhaust gases from the internal combustion operated air compressor are used to generate steam from water heated to steam temperature in the jackets of the internal combustion cylinders, and the steam is superheated by mixing with the compressed air on its way to the traction cylinders. Steam at 200 lb. pressure has a temperature of 388 deg. Compressed air at 200 lb. pressure has a temperature of over 670 deg. Hence the superheating effect by simply mixing. The steam forms about 20 per cent. of the mixture, and is carried in a finely divided state by the compressed air, so that initial condensation in the traction cylinders is prevented, and the superheated state of the steam is maintained throughout the expansion period with the result that about 40 per cent. more power is developed by the steam in the mixture than would be developed by the steam if used without compressed air.

Your statement that the Augsburg internal combustion locomotive with compressed air transmission is to operate at 100 lb. pressure, indicates an attempt to compromise between the temperature of compressed air and the temperature that may be realised in an air heater heated by the exhaust gases from the internal combustion cylinders. The temperature of compressed air at 100 lb. pressure is over 400 deg. If it is sought to increase that to 500 deg., the exit temperature of the heater must be at least 550 deg. This leaves 300 deg. to do the heating, and gives a heater efficiency of 35 per cent. only, which seems to indicate a large heater. The low pressure of 100 lb. indicates large traction cylinders. There is no doubt, however, that the efficiency at the rails will be greater than that of any electric transmission locomotive.

JAS. DUNLOP.

Glasgow, November 21st.

THE LAY OF WIRE ROPES FOR DRILLING.

Sir,—The writer of an article headed "The Correct Lay for Wire Lines Used upon Oilfields," which appears in the current issue of THE ENGINEER, has ignored or overlooked so many essential "variables" when carrying out the experiments upon which he bases his argument that it is by no means an easy matter to refute him.

Under certain conditions a left-hand line will unquestionably tend to unscrew a right-handed tool joint, and it seems highly probable that it was just these conditions which were reproduced in the experiments described. They do not, however, occur in practice under normal circumstances ; when they do, tools are often left in the bore owing to joints slacking off.

Mr. Hayward seems to have entirely ignored the action of the swivel, the purpose of which is to maintain the direction of rotation of the string of tools clockwise or right-handed. The sequence of action of tools in the bore is as follows :—

(1) As the tools are lifted off bottom the two members of the rope swivel are, to all intents and purposes, locked together owing to the relatively small surfaces in contact over which the load due to the weight of the tools is distributed, and the right-handed tendency of the line is transmitted to the tools, which therefore rotate clockwise.

(2) At, or near, the top of the stroke the inertia of the tools, owing to their vertical motion, throws the load off the swivel, the spindle of which is then free to follow the left-handed twist of the line caused by its release from the load of the tools, which occurs just before reversal of movement takes place in the walking beam. So far, it will be noted, every tendency is to tighten the right-handed tool joints.

(3) On the downward stroke the line is again loaded, though to a lesser degree, and a clockwise tendency is again imparted to the tools.

(4) Tools strike bottom while rotating clockwise and inertia of drill stem, jars and swivel tends to tighten joints, if these are right-handed.

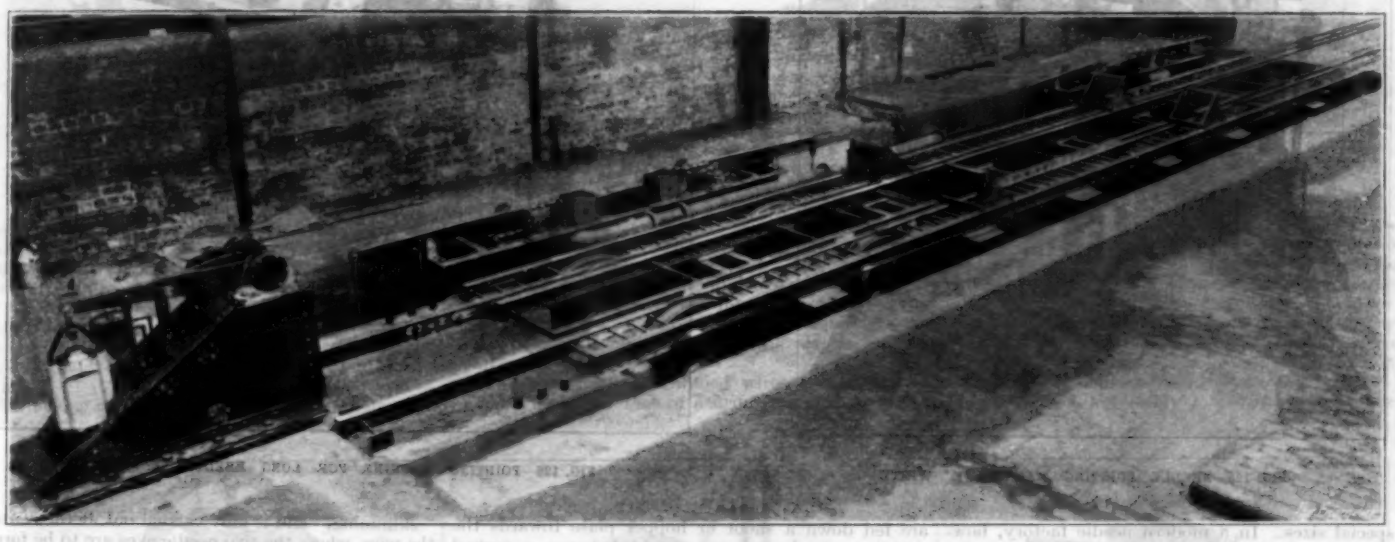
It will thus be seen that a left-hand lay line can have no other effect than to tighten right-hand tool joints.

The above description is true only in a "clean" hole and with a good "gait" on the drilling rig ; tools may unscrew in a foul hole, or when running "tight," and the most usual cause of unscrewed joints is "burring" of the swivel members, or the presence of fine sand, both of which cause jamming and prevent the swivel from rotating, thus causing the string of tools to oscillate about their axis instead of rotating constantly in one direction.

Mr. Hayward is probably aware that the cup on the bottom of the ordinary clack valve bailer has a left-handed thread, while a right-handed "sand line" is usual practice ; hence a bailer held fast at the bottom of the bore by its cup can generally be released—at the sacrifice of the cup—by "surging" continuously on the sand line, when the left-handed thread of the cup will eventually unscrew. This apparent paradox may provide Mr. Hayward with a further problem for experimental research !

PAUL H. MANGIN.

London, November 24th.



THE NORTH BRITISH LOCOMOTIVE COMPANY'S ENGINE TESTING PLANT

THE INSTITUTION OF WATER ENGINEERS.—The twenty-ninth winter general meeting, being the fourteenth statutory annual general meeting of the Institution, will be held at the Apartments of the Geological Society, Burlington House, W., on Thursday, December 4th, 1924. The chair will be taken by the president, Mr. J. Chisholm, M. Inst. C.E., at 10.30 a.m. The following papers will be read and discussed :—"Iron Deposit in Cast Iron Pipes," by J. R. Fox, M. Inst. C.E. ; "Fluctuations of Annual Rainfall : Three Driest Consecutive Years," by John Glasspoole, M.Sc., A.I.C. ; "The Biology of Jersey Waterworks," by W. Rushton, D.Sc. (Ill.), A.R.C.S., D.I.C., F.L.S. (London), with an addendum by A. J. Jenkins, Assoc. M. Inst. C.E. ; "On the Preparation of a Rainfall Map of the British Isles," by the late M. de Carle S. Salter, Superintendent of the British Rainfall Organisation.

CONDUCTORS FOR OVERHEAD POWER TRANSMISSION.—The British Engineering Standards Association has just issued a specification for hard-drawn copper solid and stranded circular conductors for overhead power transmission, the data in which are based on the results of extensive tests on hard-drawn copper conductors carried out by the British Electrical and Allied Industries Research Association and also by the National Physical Laboratory, and are of considerable interest, in that they are the first authoritative data to be published in this country on hard-drawn copper conductors. Four tables are included in the specification, two dealing with solid (single) conductors, and two with stranded conductors. In each case two series of standard sizes are given, a primary series for use whenever possible and a secondary series for use when it is impracticable to use the primary series. The Committee responsible for this specification has adopted these two series of sizes in the hope that the secondary sizes will eventually fall into disuse and that the primary sizes will then be used in all but very special cases. Mechanical and electrical tests are specified for all sizes, as are also the weights per 1000 yards and per mile. This specification is of special importance in view of the regulations for overhead lines prescribed by the Electricity Commissioners, wherein it is stated that "all line conductors at the time of erection shall comply, as regards elongation, breaking load and elasticity, with the specification of the British Engineering Standards Association then in force." Copies of the publication (No. 125–1924) may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

British Wire-drawing and Wire-working Machinery.

No. XVII.—NEEDLE MAKING.*

ALTHOUGH the finished form of the ordinary sewing needle has been fixed for generations past, it is noteworthy that there has been constant progress in the methods used in its manufacture, and new machines which help towards the cheapening of production are still being designed and manufactured. Less than one hundred years ago needles were made entirely by hand, the method being to cut the wire off to the length of the needle, flatten one end with a hammer on an anvil, and indent it on the flat, which was the first process of forming the eye. The wire was then laid on a lead block and the hole punched through it. The head was then filed to shape and the eye guttered out at the end. The points were produced by grinding or filing. There are instances on record in which orders were being accepted and fulfilled for needles made in this manner at 2s. 6d. per 1000, finished ready for the market, but the work was naturally tedious and required a high degree of skill and practice. There are, nevertheless, departments in some English needle factories where many of the old-fashioned processes are still employed for making small parcels of special sizes. In a modern needle factory, however, almost all the operations are effected in automatic machines, and those described in the following article are made by Mr. Edward White, of Redditch, the town in which practically the whole of the needle-making industry of this country is centred. Mr. White, by the way, claims to be the largest maker of this class of machinery in England, and also that his is one of the very few firms in the world able to turn out a complete needle-making plant.

The first operation in the manufacture of needles is to cut the wire into lengths, and a very convenient form of machine for this purpose was illustrated and described in the fourteenth article of this series. It is, however, the practice of some needle makers to buy the wire ready cut to length. Each length of wire is double the length of the finished product, as needles are made in pairs—head to head.

The wires must next be annealed, and for that purpose they are made up into bundles and slipped into heavy steel rings—a pair of rings for each bundle. The wires are heated to a moderate red heat, taken out of the furnace and placed on a flat iron table, still held by the rings. A man then takes a rubbing file or heavy, slightly curved, bar, and, pressing on the top of the bundle of wires, as indicated in the sketch, Fig. 124, rubs them backwards and forwards. The result is that the wires revolve on their own axes and by bearing against one another are mutually straightened.

The next operation is to point the wires, which is effected by grinding. At one time the grinding wheels employed were of grit stone, but carborundum wheels are now almost exclusively used, as they not only cut quicker and last longer, but also are much less liable to accident through bursting. The general appearance of a needle-pointing machine may be gathered from Fig. 125, while the sketch, Fig. 127, shows the essential working parts and the method of operation. Fig. 126 represents a special machine extended for pointing very long needles.

The point of a needle is not, of course, truly conical, but is rounded, and the gradually increasing taper is produced by the simple expedient of presenting the wire to the grinding wheel at a progressively decreasing angle. That is to say, the extreme point is first produced, and the angle of grinding is gradually reduced until it merges into the parallel part of the needle. This effect is produced by feeding the wires up to the grinding wheel at first at an appreciable angle to its periphery, and so arranging things that by the time they have traversed the width of the wheel the wires are lying tangentially.

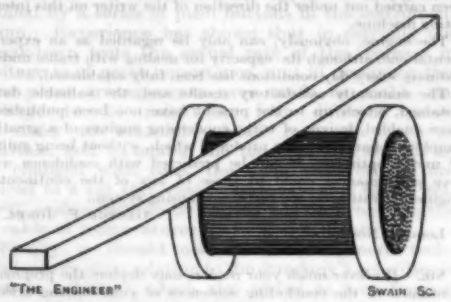


FIG. 124

On reference to Fig. 127 it will be seen that the wires are fed down a shoot or hopper plate towards the grinding wheel, and are caught between a curved saddle and a rubber-faced feed wheel. In this position they are gripped between the wheel and saddle, with the ends to be pointed projecting beyond the edge of the saddle, and as the feed wheel is rotated the wires roll forward across the grinding wheel. It will be noticed that the feed wheel is set at a considerable angle to the grinding wheel, and that provision is made for adjusting the angle—see Fig. 125—through a considerable range. It is this angle which determines the contour of the point ground on the wire, and it requires considerable skill to set the machine properly, as incorrect setting may result in so much work being put on the grinding wheel at some portion of its width that the wire is overheated and spoiled. When everything is in good running order, the work of grinding is so evenly distributed across the face of the wheel that the wire is never more than just dull red hot. After passing right across the grinding wheel, the wires are delivered down a shoot and are returned to the feed side, in the opposite direction, for pointing at the other end.

It should be pointed out that the grinding wheel runs away from the wires, which consequently have to be gripped sufficiently tightly between the feed wheel and the saddle to prevent them being drawn forward by the grinding action. The bearings for the two wheels can be adjusted for accommodating wear, and the feed wheel can be speeded up by gearing when it becomes necessary to true up its rubber face. A fan is provided to carry away the dust produced during grinding. The output of one of these machines is about 40,000 needles per hour.

At this stage the wires still carry a considerable amount of the scale produced when they were annealed, and as the next operation involves the use of some very delicate punches, this scale must first be removed. This work is known in the trade as "skimming," and is only carried out at the centre of the wire, where the two needle eyes are to be formed.

The skimming is effected in a machine, of which an illustration is given in Fig. 128, by means of a band faced with emery. The pointed wires are put in a hopper and fall down on to a pair of slowly rotating cast iron discs, between which there is another disc of slightly smaller diameter. This central disc forms a pulley for carrying the emery-faced band, that is driven by the large pulley seen beneath the table of the machine. Outside the cast iron discs there is a saddle between which and the discs the wires are fed. The result is that as the wires are dragged forward by the discs they roll against the saddle and are consequently polished all round by the emery band running below. One of these machines is capable of skimming some 100,000 needles an hour.

The next process is to make the eye in the needle, which is performed in two operations, but is often effected in a single machine. There is, however, some divergence of opinion as to the wisdom of carrying out both operations in one machine, and some manufacturers prefer to use two machines, as being less liable to upset the working of the factory in the event of a breakdown. In any case, however, there is little difference in the actual process of making the eyes.

The eye of a needle is punched out, but as a simple punching operation would leave a ragged edge to the hole, the two-fold process just mentioned is adopted. In the first place, the wire is stamped between two dies, which form the two adjacent needle heads, but do not pierce right through the hole. The metal of the wire is squeezed out to form the rounded edges of the eye-hole and spreads out at the sides, as a fin or "flash," while a thin diaphragm is left in the middle of the hole. In the second operation this diaphragm is punched right out, leaving a smooth rounded hole, while the fins are subsequently removed. At one time, and it is not so very long ago, the stamping was done under little drop hammers operated by a foot stirrup, while the piercing was carried out by hand-operated screw presses; but automatic machines are now used for the work almost exclusively.

The simple stamping machine—see Fig. 129—needs

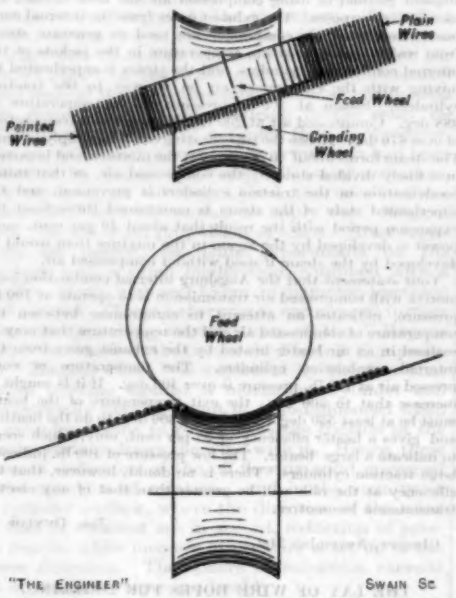


FIG. 127

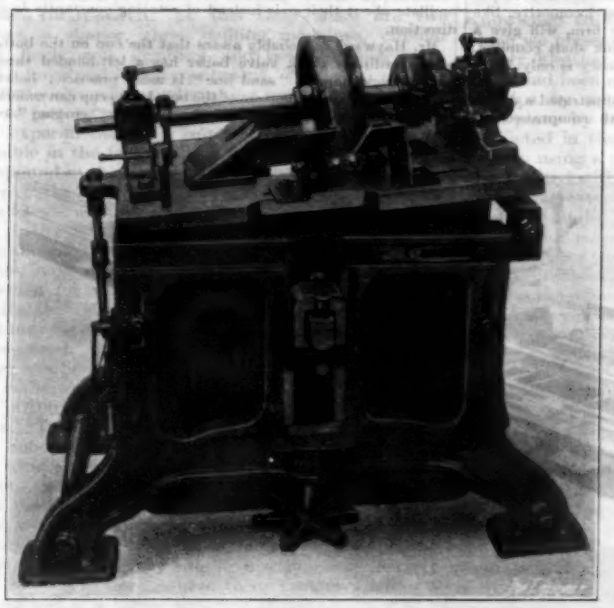


FIG. 125—NEEDLE POINTING MACHINE—E. WHITE

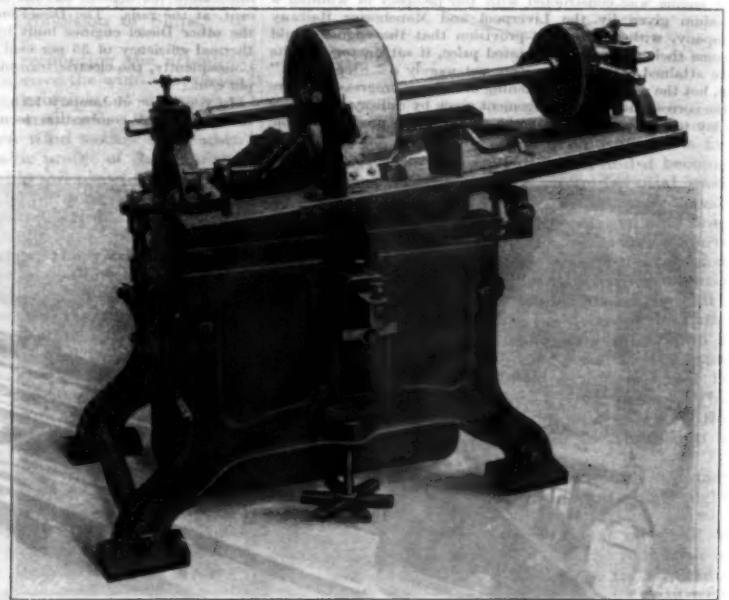


FIG. 126—POINTING MACHINE FOR LONG NEEDLES—E. WHITE

* No. XVI. appeared November 21st.

little description, as it is similar in general principle to a nail heading machine, except that the wire is presented to the dies sideways instead of end on. The wires are placed in a hopper and are fed forward by a grooved roller, which is geared with the main shaft and consequently feeds a wire in for each stroke of the dies. The wire falls on to a pair of gauges in front of the fixed die and is set in position by a cam and lever bearing against its end. The moving die is pushed back by a cam on the main shaft and when

FIG. 128—SKIMMING MACHINE—E. WHITE

released is driven forward by a spring. After the wire has been stamped it is thrown clear by a pair of cam-actuated forks. The dies are so mounted in the anvil that they can be accurately adjusted in position and are themselves made by stamping with a master die. The die must, naturally, be hardened and tempered after being stamped. These machines are run at such a speed that they will stamp about 10,000 needles an hour.

The eyeing process is carried out in the machine shown in Fig. 130, into which the stamped wires are fed down the inclined table shown. The wires are picked up by a revolving drum and deposited, one at a time, on a pair of horizontal square-threaded screws. The first few threads of these screws have wide bottoms, so that the wires will readily drop to the bottom, but further on the threads narrow down to confine the wires more precisely. The consequence is that as the screws rotate the wires are carried forward truly normal to the direction of travel. Towards the end of the screws the wires are slid over the top of a knife edge and as the previous stamping operation has flattened out the centre of the wire this knife edge ensures that the wires will be turned over on the flat in the proper position to be eyed. At the end of the screws the wires are taken by a pair of forks and deposited on the die just before the punch descends and punches out the thin film of metal which has so far blinded the eye. There is a stripper plate to prevent the needles rising again with the punch and a pusher bar to throw the eyed wires on to a tray at the back of the machine. It is noteworthy that the punches are made of the same quality of wire as the needles themselves.

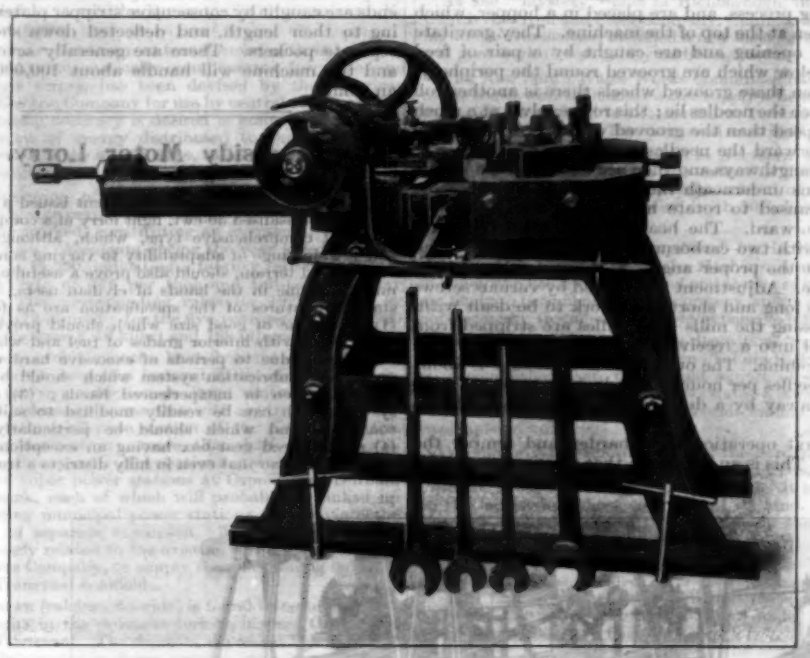


FIG. 129—STAMPING MACHINE—E. WHITE

The combined stamping and eyeing machine—see Fig. 131—more closely resembles the eyeing machine just described than the stamping machine shown in Fig. 129, in that both operations are carried out vertically.

The pointed and skimmed wires are fed from a hopper on to the face of a drum furnished with fine longitudinal grooves. The wires are carried round in these grooves, but if a bent wire should appear it will project from the groove and as the drum rotates will catch against a closely fitting fence. This fence is connected with the belt striking gear and the machine will consequently be stopped before any damage is done by the defective wire.

The wires are dropped by the drum on to a pair of feed screws somewhat similar to those of the simple eyeing machine; but as the wires have subsequently to be transferred from the stamping to the eyeing position, the screws are extended beyond the stamping anvil. Opposite the anvil the threads on the screws have one turn cut down much more deeply than the remainder, so that the weight of the wire may be transferred from the screws to the eyeing pad. While the wires are lying on the eyeing pad a pair of gauges descends and the wire is blown against them by a strong blast of air. Provision has also to be made for preventing the screws from continuing to feed the wire forward during the operation of stamping, and that is effected by momentarily moving the whole slide carrying the screws in the opposite direction to the travel of the wires, so that the wire remains stationary. Immediately after the stamping die has done its work the stop gauges rise and allow the wire to proceed along the feed screws to the eyeing press, which is very similar to that already described.

The bottom die of the stamping bed in these machines is carried in a spherical shaped cup, so that it can be set accurately in position, and there are

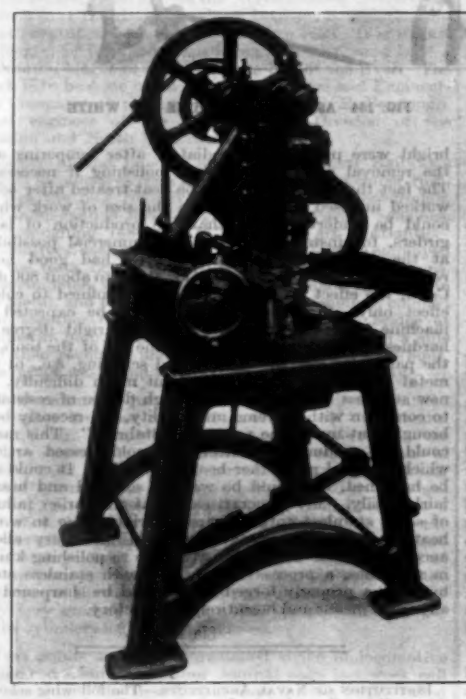


FIG. 130—AUTOMATIC EYEING MACHINE

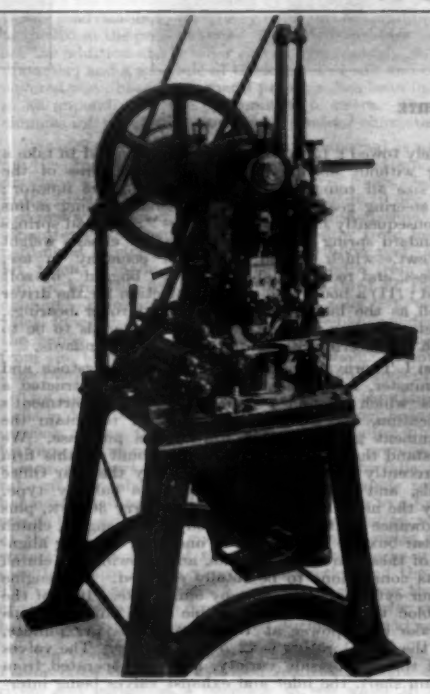


FIG. 131—COMBINED STAMPING AND EYEING MACHINE

FIG. 132—AUTOMATIC HEAD GRINDING MACHINE

generally about a dozen impressions, side by side, on each die block, which are used in turn as they wear out. The top die is a little cube of steel with narrow facets along each corner, and these facets are each provided with an impression so that the one die has twelve working faces. The punchings from the eyeing process are drawn away by a fan connected with the underside of the eyeing bed. The output of one of these combined machines is some 25,000 pieces per hour.

The next process is to remove the flash or surplus

metal from around the head of the needle. In many places this operation is done by threading the needles on flat pieces of wire and taking them in a pair of wide-nose pliers or clams and grinding them on an ordinary flat aloxite wheel. In this way the sides of the eyes or "cheeks" are finished, and the wires are then broken through, thus separating them into individual needles for the first time. The grinding is then continued around the head. In more up-to-date works, however, this process is accomplished on an automatic machine such as that shown in Fig. 132. The needles are broken through immediately after the eyeing process, and are placed in a hopper, which can be seen at the top of the machine. They gravitate down an opening and are caught by a pair of feed wheels below which are grooved round the periphery. In between these grooved wheels there is another roll upon which the needles lie; this roll revolves at a much greater speed than the grooved wheels. As the wheel travels forward the needles are first gauged or set in position lengthways and then are carried into a saddle which runs underneath the centre roll. Each needle is thus caused to rotate upon its own axis as it is carried forward. The heads are then brought into contact with two carborundum grinding mills, which are set at the proper angles to shape to the head of the needle. Adjustment is provided by various screws to enable long and short-eyed work to be dealt with. After passing the mills the needles are stripped from the wheel into a receiving tray on the delivery side of the machine. The output of this machine is about 25,000 needles per hour. The dust from the machine is taken away by a duct connected with an exhaust fan.

The next operation is to harden and temper the needles. This is an operation that requires great care to length, as it is not possible to ensure that they will all be exactly to standard length. The variations between the longest and shortest of any nominal size is only about $^1/_{16}$in., but it is not considered desirable to pack together needles of such divergent lengths. They are consequently passed through the assorting machine shown in Fig. 134.

This machine comprises a slowly rotating wheel with fine grooves in its periphery. The needles are fed into these grooves from a hopper and are all brought level at one end by bearing against a gauge plate. Then, as the needles are carried on by the wheel, the opposite ends are caught by consecutive stripper plates, according to their length, and deflected down shoots into separate pockets. There are generally seven shoots and the machine will handle about 100,000 needles an hour.

Subsidy Motor Lorry.

In July, 1922, the War Department issued a specification for a subsidised 30-cwt. light lorry of a comparatively new and comprehensive type, which, although possessing a wide range of adaptability to varying conditions of climate and terrain, should also prove a useful and economical machine in the hands of civilian users. The outstanding features of the specification are as follows:—(1) An engine of good size which should provide ample power even with inferior grades of fuel and when rather out of tune due to periods of excessive hard work; (2) an efficient lubrication system which should be easy of attention even in inexperienced hands; (3) a cooling system which can be readily modified to suit tropical conditions and which should be particularly hardy; (4) a four-speed gear-box having an exceptionally wide range of gears so that even in hilly districts a trailer could be safely towed; (5) a frame specially designed to take a trailer without detriment; (6) pneumatic tires of the same size all round; (7) a power driven tire inflator; (8) a steering gear providing for a small turning radius and consequently unusual "handiness"; (9) road springs of standard spring steel sizes; (10) a low chassis weight —29 cwt.—which should make for economy in use, liveliness, and reduced liability to get "bogged" on soft ground; (11) a body with ample protection for the driver as well as the load; and (12) ball and roller bearings, magneto coupling, screw threads and materials to be to British Engineering Standards Association standards.

John I. Thornycroft and Co., Limited, Basingstoke and Westminster, have recently designed and constructed a chassis which complies with the War Department's specification, and enables the purchaser to obtain the Government grant of £120 towards its purchase. We understand that two completed lorries built by this firm have recently undergone drastic tests by the War Office officials, and have been accepted as a subsidy type. Briefly the new chassis is designed to carry 30 cwt., plus an allowance of 10 cwt. for the body. The engine, clutch and gear-box are constructed as one unit, ensuring alignment of these three components, and allowing the clutch and its connections to be totally enclosed. The engine has four cylinders, 3¼in. bore by 5in. stroke. It is of the monobloc type with a detachable head, and develops 36 brake horse-power at 1500 revolutions per minute, while the R.A.C. rating is 22.5 horse-power. The valves are of the side-by-side variety, and are operated from one cam shaft, the inlet and exhaust valves being interchangeable. To enable the inspection of the main and big-end bearings to be carried out without removing the engine from the chassis, the bottom half of the crank case can be removed without disturbing the main bearings. Aluminium pistons are used, and forced lubrication is provided to the main bearings and big ends. Cooling is effected by means of a pump and fan, and the pump being of the propeller pattern, does not impede the circulation of the water when out of action. Another good feature of the cooling system is the method of constructing the radiator, which is of the gilled tube type. The tubes are $^5/_{16}$in. bore, and are mounted on cups fitted with cup-shaped rubber buffers. The radiator is built up with removable top and bottom vessels, which enable new tubes to be easily fitted.

The clutch comprises a single steel plate engaging with asbestos fabric surfaces, and the gear-box has four forward speeds and a reverse. The final transmission is by means of a hollow propeller shaft connected with a gear-box and worm shaft by fabric universal joints. The worm wheel and differential can be taken out when necessary without removing the rear axle from the chassis. Both hand and foot brakes, of the internal expanding type, operate on drums on the back wheels and are easily adjustable without the use of tools. Many other improvements, all intended either to prolong the life of the vehicles or to facilitate adjustments without incurring heavy expense, are incorporated in the chassis design. The wheel base is 11ft. 6in. and the track of the front wheels is 60in., while that of the rear wheels is 58in. Provision is also made for the fitting of a self-starter, a dynamo lighting equipment, and mechanically-operated tire pump.

It should be pointed out to purchasers of the subsidy vehicles that the chassis or the complete vehicle with any type of body will be accepted for enrolment by the Government for a period of three years, ensuring the payment to the owner of £120, in six half-yearly instalments of £20, in advance, subject to a half-yearly inspection. Enrolment entitles the War Department to purchase the chassis or vehicle in case of national emergency only, involving the calling up of the Army Reserve, at a price fixed by agreement on enrolment.

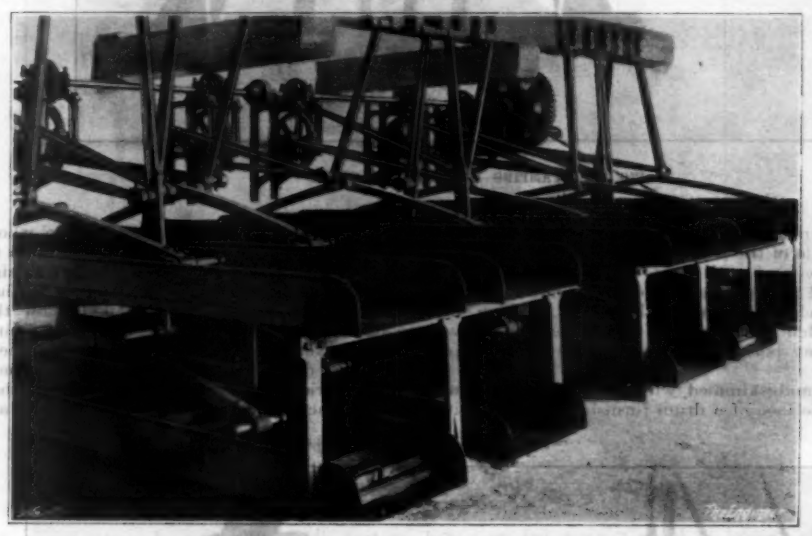


FIG. 133—SCOURING MILL—R. WHITE

FIG. 134—ASSORTING MACHINE—R. WHITE

STAINLESS STEEL.

At an informal meeting of the Junior Institution of Engineers on Friday, November 21st, Mr. J. G. Hopcraft, in discussing stainless steel, dealt with the methods of working the metal by forging, casting and rolling, &c., and with the heat treatment. He said that it should be understood that the special properties of stainless steel were inherent properties and not merely superficial. The ability to withstand heat and corrosion and to remain in consequence of the sensitiveness of the material employed and the very small size of the articles. The needles are placed in stacks of about 10,000 on a pan and heated to the required temperature; they are then plunged into cod oil, which hardens them. They are removed from this oil after cooling and again placed upon pans and put in an oven which is heated to a much lower temperature in order to bring the needles back to a proper temper.

The next process is the polishing of the needles. This is known in the trade as "scouring," and to the uninitiated is a somewhat clumsy process, but it is found to be the cheapest and most effective method of polishing needles and other small articles to a clear surface. The needles are made up into rolls, mixed with emery powder or sand and soft soap, and wrapped round with canvas secured with cord. The rolls range from 28in. to 30in. long by about 5in. in diameter, and may each contain about 40,000 needles. Two of these rolls are placed one under either end of a flat steel plate and on a steel table. The plates are weighted and are reciprocated by gearing as shown in Fig. 133, so that the packets are rolled backwards and forwards. The friction of the needles, among themselves, and with the emery scours off the scale, and after some twelve hours the packets are opened, the needles thoroughly washed in strong suds and the rolls made up again with a fresh supply of grit. After several scourings the emery is replaced by putty powder or some such material, in order to give the needles a well glazed surface.

During the process of scouring the fine points of the needles are naturally dulled somewhat, and the better classes of needles are consequently given a final pass through a machine very like the original pointing machine, in order to give them a keen point. Another refinement is the polishing of the insides of the eyes, which is effected by threading the needles on to emery-covered threads and drawing them backwards and forwards by hand.

The final operation on the needles before they go to the packing department is to assort them according bright were produced immediately after tempering and the removal of the scale, with polishing if necessary. The fact that the steel had to be heat-treated after being worked imposed a limitation on the size of work which could be undertaken, so that the production of large girders, for instance, was not a commercial possibility at the present time. Stainless steel had good heat-resisting qualities, and would not scale up to about 800 deg. Cent., the effect on the surfaces being confined to colour effect only. Stainless steel could not be expected to machine like mild steel, but with the right degree of hardness and a little experience in the use of the tools for the particular job, the turning and screwing, &c., of the metal could be carried out without much difficulty. A new stainless steel, combining a high degree of resistance to corrosion with extreme malleability, had recently been brought out under the name of "Stabrite." This metal could be produced in sheets for cold-pressed articles which required no further heat treatment. It could not be hardened, but could be welded, soldered and brazed fairly easily. Mr. Hopcraft said that the earlier failures of some stainless cutlery were invariably due to wrong heat treatment or wrong forging. Unnecessary allowances were made at first for wear due to polishing knives in machines, a process unnecessary with stainless steel, but now a properly forged blade could be sharpened by any usual means and be entirely satisfactory.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships will be offered by the Institution of Naval Architects for competition in 1925:—Naval Architecture: "Elgar" Scholarship (£130 per annum) and "Armstrong" Scholarship (£15 per annum. Marine Engineering: "Parsons" (£150 per annum), "Yarrow" (£100 per annum), and "Denny" (£75 per annum, open to boys, British subjects, from approved public schools or schools under the education authorities). With the exception of the last-named, all these scholarships are open to British apprentices or students who have not yet entered upon a university course, and they are tenable, subject to the regulations governing each scholarship, for four years at Glasgow University, with which is affiliated the Royal Technical College, Glasgow, and for three years at Durham University (Armstrong College), Liverpool University, the Royal Naval College, Greenwich, and the City and Guilds (Imperial) College of Science and Technology, London). Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5, Adelphi-terrace, London, W.C. 2.

Railway Matters.

The two London and North-Eastern engines—Locomotion of 1825 and Flying Scotsman of to-day—that were shown at the British Empire Exhibition, were exhibited at York on Saturday and Sunday last in aid of the York County Hospital.

For the purpose of conferring with the Railway Board of India on the standardisation of locomotives and rolling stock, it is proposed that Sir Seymour B. Tritton should make an extensive tour of India, Burma and Assam during the forthcoming cold season.

A large armour plate evidently fell off a goods train near Aycliffe on the night of the 12th instant and lay foul of the line on which an express passenger train subsequently ran. The latter struck the plate but was not derailed. The engine and permanent way were damaged and the electric light generating apparatus under the carriages was swept away.

In the paper "Signalling on the London Underground Railways," by Mr. W. S. Every, read at the Institution of Railway Signal Engineers on November 12th, the following statistics as to the signalling on the Metropolitan District and London Electric Railways were given:—Length of line, single track, about 150 miles; cabins, 58; controlled signals, 759; automatic signals, 527; repeater signals, 301; fog repeaters, 123; points, 418; track circuits, 1209.

Two handsome war memorials made in brass and stone by Crewe railwaymen were unveiled on Armistice Day at the Crewe north and south locomotive sheds. Over 300 enginemen from the sheds joined the Forces, and forty-six were killed. During the ceremony one of the latest and most powerful engines on the London, Midland and Scottish Railway, which had been named Patriot and bearing a large plate inscribed in memory of the fallen soldiers, stood by.

The Great Southern Railway (Ireland) has now been constituted by the amalgamation of the Great Southern and Western, Midland, Great Western and the Cork, Bandon and South Coast companies. Mr. J. F. Sides is the chief engineer, Mr. A. W. Bretland the deputy chief engineer, Mr. J. R. Bazin the chief mechanical engineer, and Mr. W. H. Morton the deputy chief mechanical engineer; Sir William Goulding is the chairman, Mr. C. E. Riley the secretary, and Mr. M. F. Keogh the general manager.

The Signal and Telegraph Branch of the Victorian Government Railways has, where necessary, provided its officers with a book of lithographed detail drawings of parts of apparatus and structures, &c., reduced to a standard size of 8in. by 13½in. These will be particularly useful out of doors, where hitherto engineers, signal supervisors, foremen and others have been obliged to use blue prints of all shapes and sizes—an awkward business, particularly in wet or windy weather. The innovation promises to have a high educational effect also. The books are kept up to date by means of prints sent to all holders of plan books.

What is probably the last timber railway viaduct in the North of England and, with the exception of two or three on the Falmouth branch, possibly the last in this country, is about to be replaced by a steel structure. This is the bridge which carries the North-Eastern Newbigging branch over the river Wansbeck between Bedlington and North Seaton and has been in use since 1859. It is 1070ft. in length, of forty-three spans, each of 25ft., and is of a maximum height of 86ft. from the bed of the river. The work is to be done by the Cleveland Bridge and Engineering Company, to plans prepared by Mr. C. F. Bengough, chief engineer of the North-Eastern Division of the London and North-Eastern Railway.

Eight of the London and North-Eastern Railway's largest locomotives were used on Sunday, November 16th, to test the new Nene Valley viaduct at Peterborough. The main span is 220ft. long, and two "Pacific" engines, each weighing 148 tons 15 cwt., and six "Atlantic" locomotives, each weighing 112 tons 14 cwt., were employed for the tests, or a combined weight of nearly 1000 tons. Deflectometers were used in order to calculate the stress in the metal, and for the first test the eight engines, coupled four together on each line, passed over the bridge at 8 miles an hour. They went down the line for half a mile and then reversed, and came back at 40 miles an hour. The bridge was found to be satisfactory in every way.

The coroner's jury in the Lytham derailment of November 3rd has returned a verdict of "Accidental death." In summing up, the coroner referred to the various rumours in connection with the accident, one of which, with regard to the fire after the accident being caused through the carriages being provided with gas lighting, he had heard himself. He thought it was a fact that the coach which was actually on fire was the only coach that had the lights burning after the fire had been extinguished. More than that, he believed that at certain periods over several hours after the accident, the cylinders in that coach showed pressure of gas, which was only very gradually relaxed. That showed that the gas in the cylinders had not been ignited.

Two points as to the threatened strike of locomotive enginemen mentioned in our Journal page last week call for mention. The first is that were such a strike called it would be the second repudiation by the Associated Society of Locomotive Engineers and Firemen of its representatives' signature. It will be remembered that nearly a year ago the National Wages Board made an award in which the society's representatives concurred. It increased the mileage per day from 120 to 150, but when it was to come into effect the Society's men struck work. This strike came to an end on an agreement being reached between the companies and the Society that the increase should come into force gradually—the advance from 140 to 150 being made from the beginning of the first pay week in January, 1925. The second point is that at the time an intimation of a possible crisis appeared in the Press, a meeting was being held between representatives of the Society and the general managers on this very subject!

Notes and Memoranda.

The ventilating fan for the gold mines on the Government Areas of South Africa, which is to have a capacity of 900,000 cubic feet per minute, will be, according to the *S.A. Mining and Engineering Journal*, the largest of its kind in the world.

The Thyssen Company in Germany has, according to the *Iron and Coal Trades Review*, tested a new invention for detecting the presence of fire-damp in mines, which is reported to have proved so successful that the company has decided to install the apparatus in all its mines. No details are given.

A new instrument current transformer, with an auxiliary circuit, that automatically compensates for ratio and phase-angle errors, has been devised by the American General Electric Company for use by central stations where high metering accuracy is desired in connection with the measurement of energy distributed to customers. The instrument is of the wound type, rated at 4500 volts, with current ratings up to 600 ampères.

The operation of American stone quarries in 1923 required the services of 92,455 men, and a total of 25,545,859 shifts were worked, constituting an average of 276 work-days per man. Accidents during the year killed 143 men and injured 14,990, indicating a fatality rate of 1.68 and an injury rate of 176 per thousand full-time, 300-day workers. The corresponding rates for 1922 were 1.92 killed and 172 injured; for the five-year period 1916–1920 similar rates were 2.10 killed and 160 injured.

The past twelve months have brought the Union of South Africa a long step forward in the direction of co-ordinate power production in large units. The power station at Colenso in connection with electrification of the Pietermaritzburg-Glencoe section of the Natal main line is nearing completion; more than half should be in operation this year. Negotiations are in progress in relation to super power stations at Cape Town, Durban, and Witbank, each of which will probably be linked up with existing municipal power stations, and obviate the necessity of separate expansion. The Witbank station will be closely related to the existing plant of the Victoria Falls Power Company, to supply the gold mining industry and the Transvaal coalfields.

Fluorspar (calcium fluoride) is found to occur in workable deposits in the dolomite formation near Ottoshoop, Zeerust, Transvaal. The deposits at present being worked are roughly circular in shape, varying from 70ft. to 150ft. across, extending from surface downwards to a depth not yet determined. The deepest workings are at present about 60ft. Each deposit consists of extremely high-grade mineral, averaging approximately 99.5 per cent. fluorspar, with a maximum of 0.3 per cent. silica. The greater proportion is colourless, but purple, greenish, yellow, and brown samples are found. The deposits are so consistently pure and unencumbered throughout their extent with any foreign substance that no preparation is necessary before the product is marketed.

A revision of the British standard specification for metallic resistance materials (No. 115), first issued in 1921, has just been published. The sizes of wire included in the first issue had been criticised in some quarters, and these were reconsidered, but evidence was given that the sizes in question were coming more and more into general use, and the conclusion reached by the Committee was that it was inadvisable to make any considerable modifications to the list at the present time. The only important changes are the addition of a smaller size of wire (namely, 0·002in. diameter) and a schedule of thicknesses of silk and cotton-covered wire, based on general practice, has been included in an appendix for the convenience of users. The other changes in the specification are of a minor character.

The asbestos mine near Barberton, Transvaal, is situated on the Joubertdal farm, where the Jamestown series disappears below the Black Reef series of rocks. Asbestos in the form of a ribbon reef—dipping about 10 deg. N.W.—is met with immediately below a bed of sandstone, which separates green granular serpentine below from less serpentinised olivine rock above. The ribbon reef, 5ft. to 8ft. thick, is made up of bands of asbestos from ¼in. to ¾in. in breadth, which constitute one-third of the reef content. Below this is the long fibre zone, 8ft. to 10ft. thick, in which the intervals between the bands widen, and the bands themselves also widen, so that asbestos fibre from ¼in. to 6in. long is obtained from them. Below this zone there is a further 6ft. of rock with thin bands of fibre.

The survey of the scheme for harnessing the Gairsoppa Falls in Mysore has, says *Indian Engineering*, been made in such a way that the falls and surrounding physical features will in no way be disturbed. The proposal provides for a reservoir about 10 miles above the falls, and a take-off dam about 3 miles above, with canals running behind the hill on the Mysore side of the falls to a forebay about 1½ miles downstream. The power station will be at the bottom of the river gorge about 1½ miles downstream. Thus none of the hydro-electric works will be seen from any of the view-points overlooking the falls. The proposal also provides for the discharge over the falls of the normal average flow in the river, the power station being operated with water stored during the flood season.

Four years ago there was a long drought on the mid-Pacific coast of America, which reduced the flow of the rivers and permitted a backflow of sea water to much higher river and harbour points than had been before recorded. There followed the unprecedented destructive activity of the teredo and other salt water borers in riparian timber structures. This destruction ran into millions of dollars and was so sudden and pronounced as hardly to be noticed until complete failure of supported piles and timber had resulted. Word now comes from the Pacific coast by way of the *Engineering News Record* that the history of 1920 is being repeated. This year is also a year of low rainfall and the Pacific rivers, like the Sacramento, have salt content far higher than normal. The salt-loving teredo has followed the sea water and wharves have already collapsed, while others are reported to be in a dangerous condition. The lesson is plain that wherever the salinity of river water is apt to be increased by drought every precaution to discourage the teredo must be taken.

Miscellanea.

A new company, with a capital of £14,500, has been formed in the Transvaal for mining platinum at Diamant and Rietvalley. The gravel is said to have an average yield of 0.27 cwts. of platinum per ton.

The output of coal in Great Britain for the week ending on November 8th was 5,136,600 tons, which shows a slight increase on the previous week. The hands employed in getting this coal numbered 1,139,300.

At the "mystery" port of Richborough, in Kent, the Glen Irvine Iron and Steel Company, Limited, has, according to the *Ironmonger*, installed a new blast-furnace, which will give work to some sixty additional men.

The New South Wales Works Committee has approved of the south-west tablelands water supply scheme, whereby water will be supplied to Cootamundra, Temora, Wyalong, Young and Grenfell. The estimated cost is £1,616,000.

The Quinze River power plant in Northern Ontario was completed in August up to the extent of 20,000 horse-power, in two units working under a head of 70ft. The ultimate capacity of the station, with 90ft. head, is to be 60,000 horse-power.

The opinion has been expressed by Lord Inchcape that the four berths at Colombo Harbour, drawing 33ft., of which one has been completed and three are in progress, are likely to be sufficient for the present, and it is therefore not necessary to embark on more expensive schemes.

The output of the manganese deposits at Insuta, West Africa, increases yearly. When Takoradi Harbour is an accomplished fact, the annual export of manganese should total at least 500,000 tons, states a correspondent of *The Times*. The works at Takoridi cannot, however, be completed until 1927.

The new wood distillation plant of the Ford Motor Company at Iron Mountain, Michigan, U.S.A., is, says the *Chemical Trade Journal*, now in operation. It is stated to be the largest and most complete of its kind. The raw material is obtained from the motor body shops, which use over 500,000ft. of hardwood per day.

It is announced from Stockholm that the Trelleborg Town Council has decided on a great extension of the harbour by the construction of a new harbour basin, a new quay 250 m. in length, and a new mole, at a total cost of Kr. 1,000,000. Part of the work is being entrusted to the Siemens Bauunion of Berlin, the remainder being executed by the town itself.

Progress on the new development of the Ottawa River Power Company has been maintained up to schedule, and power will probably be turned on some time in December, although the power-house may not be completely fitted up by that time. The initial installation will develop 25,000 horse-power. As the sale of power warrants additional installations, a second 25,000 horse-power unit will be installed, while provision has been made for a third unit.

The Post and Telegraph Department of South Africa is installing first units of automatic telephones at Port Elizabeth and Pietermaritzburg, the long-distance wireless super-station near Capetown is in process of erection by Marconis, and, finally, wireless telephone broadcasting has already developed into a universal hobby, licensees from the Government having at various important centres installed plant and completed their organisation of broadcast concerts and news distribution.

The National Federation of Iron and Steel Manufacturers report that the production of pig iron in October amounted to 586,400 tons, compared with 569,200 tons in September and 595,700 tons in October, 1923. Last month's output included 192,900 tons of hematite, 185,300 tons of basic, 157,700 tons of foundry, and 28,500 tons of forge iron. The output of steel ingots and castings last month amounted to 678,500 tons, compared with 645,000 tons in September and 702,200 tons in October, 1923.

It has been decided by the Housing Committee of Dudley Town Council to recommend the erection of 20 houses of steel on the site belonging to the Corporation in Trindle-road. The scheme, which is an experimental one, provides for the erection of houses similar to those constructed of steel at Blackpool, which are stated to have cost considerably less than brick buildings, and to have proved satisfactory to the tenants. It is proposed to erect a large number of similar houses at Netherton should the present experimental scheme produce the satisfactory results anticipated.

Recent agitation in favour of steps being taken to maintain the United States Navy at the maximum strength possible within the lines of the Washington Agreement is reflected in the annual report of the Secretary of the Navy to Congress. The report reveals an intention to ask for an appropriation to enable six of the older battleships to be brought up to the modern standard. The Special Board appointed to deal with the question of naval aircraft has not yet, it is stated, completed its work, but it has been convinced of the importance of the air arm to the Navy. The construction programme of ten cruisers and auxiliaries which failed to obtain a passage through Congress is to be brought up again through the medium of a special report to the Sub-committee on Naval Appropriations.

The Knaresborough electricity undertaking was officially opened a day or two ago. The scheme has been carried out to the specification of Mr. George Wilkinson, M.I.E.E., of the Harrogate Corporation, and comprises an alternating-current single-phase installation taking supply at 2000 volts and distributing at 200 volts. The whole of the scheme has been carried out by the Western Electric Company, Limited, of North Woolwich, as chief contractor. The main switchboard is an eight-panel truck type board manufactured and erected by the Park Royal Engineering Company, Limited. It has two feeder panels for the cables from Harrogate, and from it high-tension feeders are taken to six transformer kiosks in various parts of the town. The laying of the cables, and the erection of the switchboards, transformers, and kiosks, for which tenders were invited as recently as May last, are now practically completed.

RESEARCH LABORATORIES, HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED

(For description see page 607)

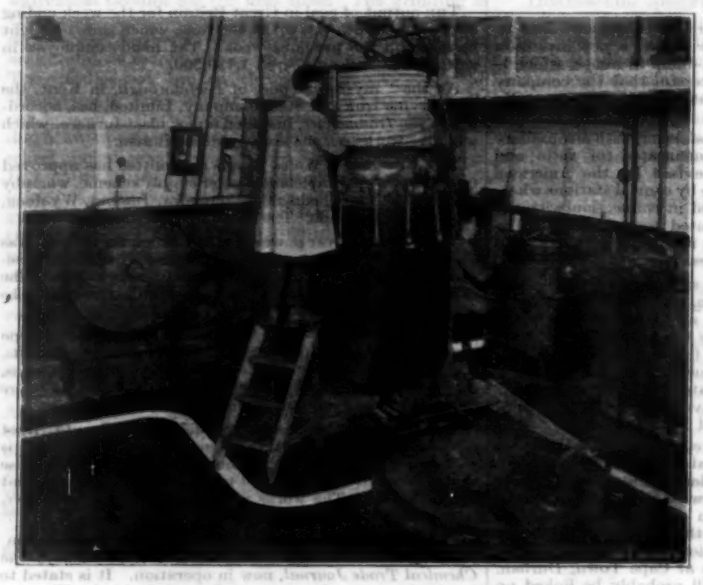


FIG. 4—EXPERIMENTAL IMPREGNATING PLANT

FIG. 5—EXPERIMENTAL RUBBER PLANT

FIG. 6—LOW TENSION LABORATORY

FIG. 7—TESTING IMPREGNATING COMPOUNDS

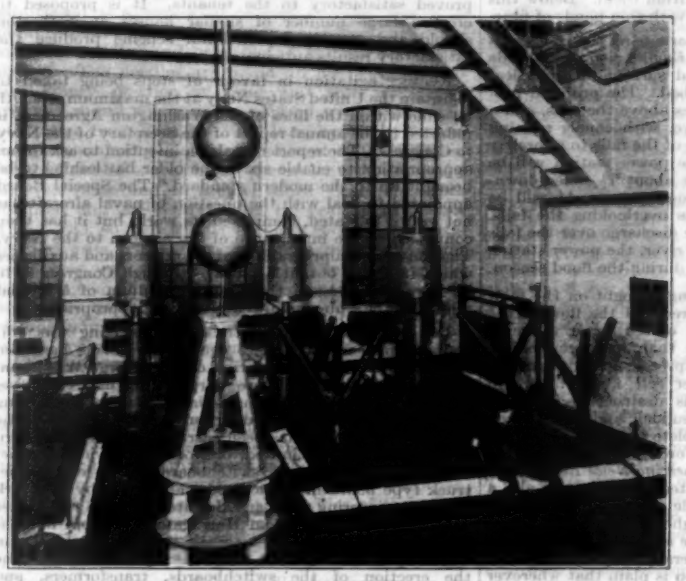


FIG. 8—HIGH VOLTAGE TRANSFORMERS AND CABLE TANKS

FIG. 9—CHEMICAL LABORATORY

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THE ENGINEER.

NOVEMBER 28, 1924.

High Temperature Materials.

We can remember an eminent Professor of Engineering, some twenty years ago, when lecturing upon the thermodynamics of the heat engine, predicting that it would not be long before we "worked our engines with red-hot steam at a pressure of 1000 lb. per square inch." Men to whom 200 lb. per square inch was high boiler pressure, and to whom the application of the mildest superheating was a daring novelty, were not ready to take such a prophecy seriously. To-day, however, there can no longer be any doubt that, even though the prophecy we have quoted has not yet been entirely realised, we are working with increasingly high pressures and still more rapidly rising degrees of superheat. On page 606 we review an extremely interesting report on the whole subject. Quite elementary thermodynamics serve to explain the increased efficiency in the use of steam or other working fluid which is attained by these means. That the practical difficulties which undoubtedly surround each step in that direction have been steadily overcome is due to another factor—the increasing demand for economy in power production, and the strenuous competition between the internal combustion engine, on the one hand, and the steam turbine on the other. We have yet to reach the stage when the entry of the internal combustion turbine carries this struggle another step forward. Meanwhile, however, there are very serious problems to be faced, problems which centre around the provision of metals possessing satisfactory working strength at the high temperatures involved.

It is unfortunately an almost universal property of metals and of alloys that their strength diminishes with rising temperature. In itself this is not an unmixed evil, since it makes it possible to work the majority of metals with ease in forging press, drop hammer or rolling mill at moderately high temperatures which are easily attainable in industrial processes. Were our metals as hard and strong at a bright red heat as they are at the ordinary temperature we should be confined largely to the use of castings, since in anything but very light sections the power required for shaping them would be prohibitively high and materials hard and strong enough for our rolls and dies would be lacking. Actually, there are a few materials to which this limitation applies. For instance, there is a very hard and strong alloy known under the name of "Stellite," which retains its hardness to so great an extent that it cannot be worked at any temperature and can only be brought to the desired shape by casting. For some rather limited purposes—limited by the high cost of the alloy as well as by the difficulty of working—this material provides a reasonable solution for high-temperature problems. But it is much too limited a solution to affect the main problem of finding alloys suitable for use in the parts of machines exposed to high temperatures and pressures, yet capable of being readily and economically fashioned to the desired shape and size. So far as the most fundamental of our materials are concerned—iron and steel—the difficulties are not yet acute. It is true that the exposure of cast iron, at least of certain kinds, to highly superheated steam leads to disastrous results, but the strength of mild steel actually increases slightly at first with rising temperature and then only begins to fall off. A temperature range is, however, reached well below a visible red heat, where the falling off in strength becomes serious. When it becomes necessary, however, this difficulty could be met by the use of certain types of alloy steel, such as the high tungsten and chromium steels now widely used for the valves of high-duty internal combustion engines. At or near 1300 deg. Fah., however, even these fail, thus setting a limit to working temperatures except in cases where they persist only for a fraction of a second, so that the maximum temperature attained by surrounding metal remains much lower, as in the case of internal combustion engines. Where steam is to be used, however, conditions are very different. It is true that steam at 1300 deg. Cent. is not, as yet a practical proposition; the increase of working temperatures has, however, been so great and rapid in recent years that we cannot afford to look at such a figure as entirely beyond the range of possibilities, and if that is the view of the engineer it becomes a definite problem for the metallurgist to seek materials capable of meeting such a future demand. The more immediate problem, however, does not relate so much to the primary materials as to those connected with accessories, such as valves and valve seatings, where hitherto the non-ferrous alloys have rendered such good service. The ordinary bronzes and brasses, however, become unduly weak and soft at temperatures which are already within the limits of our working ranges. It is perhaps possible to replace these alloys by some kind of ferrous material capable of withstanding higher temperatures, but this would mean abandoning the special advantages on account of which the bronzes have hitherto been successfully used, and, in any case, it is not a development which metallurgists interested in non-ferrous metals can afford to view with indifference.

The ordinary alloys of copper with zinc and tin fail for this purpose, and the aluminium bronzes are not much better. All these can be stiffened to some extent by the addition of more refractory metals such as nickel, but the effect, although marked, does not go far enough to make a radical advance. In this matter both America and France have shown the way, the former by the development of the alloys of the "Nichrome" type consisting mainly of nickel and chromium and a nickel-copper alloy, while in France M. Chevenard, working under the auspices of a great steel firm, has developed a number of special "high temperature" alloys. Some fairly successful efforts in the same direction have since been made here, and we understand that the British Non-ferrous Metals Research Association is taking an interest in this question. It is one undoubtedly to be commended to the attention of our metallurgists. What is needed is a group of alloys not excessively expensive either as regards raw materials or mode of production, capable of being worked up into the necessary shapes with reasonable ease and economy, and capable of resisting working stresses at temperatures of more than 700 deg. Fah.—the limit adopted by engineers to-day—or even higher in the future. We realise that this is not an easy problem and that, at first at all events, such special materials must be more expensive than more ordinary alloys. It is, however, a matter in which it is highly important that British metallurgists should not fall behind.

Mercury Vapour Rectifier Sub-Stations.

It has taken electrical engineers a long time to develop a static piece of apparatus suitable for converting alternating-current into direct-current on a relatively large scale. Whilst small mercury vapour rectifiers have been in use for many years, high-capacity rectifiers of this type are really only just beginning to make headway on electricity supply systems. That the use of revolving machinery for changing alternating current into direct current will ultimately prove quite unnecessary

under practically all conditions, we have not the least doubt. Something more akin to the static transformer than the rotary converter or motor generator has long been needed, and the more direct current is utilised the more will this need be felt. Rectification by means of static apparatus is steadily becoming a matter of greater importance to electrical engineers, who consider that a direct-current supply is essential or who find themselves compelled to give such a supply as the result of conditions which they now find it difficult to control. Mercury vapour rectifiers have recently been installed in a number of sub-stations, such, for instance, as in the sub-stations on the Midi Railway in France. In some cases certain troubles have naturally been experienced, for it seldom happens that any new piece of apparatus is free from defects, but it will be strange indeed if the difficulties met with are not eventually overcome.

The fact that a very fair number of mercury vapour rectifiers are now in every-day use is an indication that if all the faults have not already been suppressed, they are not of a very serious character. A point of considerable importance in connection with these rectifiers is that automatic control is not a very complicated and expensive business. As shown in a paper on automatic and semi-automatic mercury vapour rectifier sub-stations, read by Mr. G. Rogers at a meeting of the Institution of Electrical Engineers on November 20th, glass bulb rectifier sub-stations of the automatic type are, relatively speaking, cheap and simple, and they may be used with advantage for developing an efficient and economical direct-current supply to remote areas. The author describes a scheme of this kind which has been put into operation for supplying direct current to the thinly populated out-lying areas of Birmingham. The capacities of these stations are, however, small, and if larger metal-cased rectifiers had been necessary, the saving in capital cost which the author is able to show over rotary converter sub-stations, would probably have been very much less pronounced. Moreover, it is to be noted that the current is generated at a periodicity of 25 cycles, which, in the opinion of the author, is unsuitable for domestic purposes. There is a tendency in this country for supply engineers to follow the fashions set by the large and most important electricity undertakings, but it is well that the conditions governing the adoption of all schemes should be properly understood. As Mr. Rogers admits in the early part of his paper, where available supplies have a frequency of 40 and over, the problem is simple, as distribution on the four-wire three-phase system is easy, cheap and flexible. The network may be developed where required by means of static transformer sub-stations, and the cost of the low-tension distribution system can be reduced to a minimum. We hope therefore that the extension of direct-current distribution at Birmingham will not lead to an injudicious use of direct current elsewhere. The present position as regards distribution was clearly set forth by Mr. Charles H. Merz, in his recent paper on the transmission and distribution of electrical energy, read at the World Power Conference. The old direct-current town distribution networks, he said, usually cover the areas of densest load, and represented a large investment, so that most of them have been retained. Their effective capacity has been increased by dividing them into a number of sections, each fed by a sub-station from the high-pressure three-phase system. As a rule, the growth on the outskirts of these old networks has been dealt with by alternating current taken direct from the main transmission system. In the case of many of the smaller networks, a complete change-over to alternating current has been the ultimate result. It is now becoming usual for the larger power users to be supplied individually from the high-pressure distribution system, the low-pressure distribution being increasingly concerned with domestic supplies and small power users. The tendency in some of the bigger cities towards the erection of large blocks of flats and large stores will result in these also receiving supplies directly from the high-pressure system.

Another matter with which Mr. Rogers deals in his paper is the use of automatic booster rectifier sub-stations for feeding into existing direct-current networks, with a view to relieving overloaded feeders. Under some conditions, the scheme will be justified, but, as Mr. W. H. Selvey pointed out during the discussion on Mr. P. J. Robinson's paper on the automatic sub-station installed at Liverpool, read before the Institution of Electrical Engineers in 1923, engineers ought to consider whether it is really advisable to perpetuate direct-current distribution. Mr. Selvey argued, and, we think, rightly, that in many cases, instead of patching up the old system and making it serviceable for a time, it is better to see what would happen if steps were taken to superimpose an alternating-current system. We are inclined to think that the automatic sub-station for general supply networks is only a temporary expedient. The practice of superimposing an alternating supply on existing direct-current systems, so that the former will gradually supersede the latter, is, in our opinion, often by far the best policy, although it may not always be the best solution of the problem from the point of view of the consumer.

Literature.

The Planning, Erection and Operation of Modern Open-hearth Steel Works. By HUBERT HERMANNS, Authorised English translation. Edited by Wesley Austin. London: Ernest Benn, Limited. 1924. 42s. net.

THE production of steel ranks as one of the world's greatest industries. Indispensable as steel is to modern civilisation, indeed contributing as it has done to the development of that civilisation, new applications of it are found almost daily. This continual expansion explains, but does not render less romantic, the fact that during the year 1923 the world absorbed 78,403,000 tons of steel. The figure is startling and indeed seems almost incredible. In view of such a vast production and utilisation whence comes the present depressed state of the industry, not only in Great Britain but in all other countries as well? The answer lies largely in the facts that the world's producing capacity is over 120,000,000 tons, and production costs are too high.

Of this huge total 75 per cent. is manufactured by the open-hearth process, and this proportion is increasing. Born in 1861 in the inventive brain of William Siemens, cradled and nurtured during its early years by the help of Pierre Martin, the process is increasingly recognised as the one by which reliable steel can be manufactured, and hence its adoption in the industry. Yet, despite its sixty-two years of history, and the immense amount of capital invested, the knowledge regarding the open-hearth furnace is still ill-defined and crude. The present practice has been built up during the years by the process of trial, often very costly, and experience, often very bitter, so that most of the accepted designs of open-hearth furnaces depend rather on the fact that they are what our neighbours are using, or what our fathers used, than on any appreciation of the fundamental principles involved or the application of proved scientific knowledge. It seems curious that in a powerful and wealthy industry such should be the case.

How many other industries depends on such an inefficient producing unit as the open-hearth furnace? Thermally not more than 25 per cent. of the heat supplied is usefully employed; structurally it is subject to rapid deterioration owing to the high temperature needed and the inability of the available refractories to withstand it, and in operation it depends entirely on the care of the human element which, by incapacity, can increase the wastage or, by inattention, do damage which in a modern unit may involve a repair expenditure of £2000. It seems, therefore, that there is a field open for most fruitful research. True there are some books available which deal with sections of the subject, but they fail to meet the want in so far that they start from a point, assuming all that leads up to that point to be incontrovertible because already accepted. There are also many papers which have been written recording important results in many lines of investigation. But what the industry needs is the application to these problems of the fearless mind of an original investigator with courage enough to leave the hard beaten track and by the application of fundamental scientific principles "blaze a new trail" of economy of production along which, following its prophet, the industry would be led out of the somewhat arid and barren land in which it finds itself at present into a new land flowing with "work and money." Incidentally the prophet would probably receive the reward usually accorded to prophets but, if, in these more polite days, he escaped being stoned, he could console himself with the thought that the problem of the alleviation of unemployment has already received the attention of a paternal Government and he need not starve.

It was with meditations such as these that we approached the volume under review, and we may say at once that whilst Mr. Hermanns has not attempted the *rôle* of the prophet, yet he has given us a book which as a record of what has already been achieved will be useful to the industry as a work of reference. The translating and editing has been very well done, and it is refreshing to find a volume so plentifully illustrated with reproductions of good drawings and photographs. In literature intended for engineers illustrations are frequently more important than text, a fact that is frequently overlooked by authors.

Mr. Hermanns' experience has been gained principally with the open-hearth furnace in Germany, and the major portion of his book deals with the practice in his own country. His references to what is being done in America are brief, and his records of what is being done in Great Britain are briefer still. Whilst this partiality is natural, yet it is regrettable in a book which purposes to have an international circulation. The conditions under which the open-hearth furnace is used in Germany are entirely different from those which exist either in America or Great Britain, and since any consideration of the suitability of a certain design of furnace is fundamentally wrapped up in the service the furnace is desired to give, the practice of one country may be quite unsuitable for another. The major production of steel in Germany is effected by the Thomas process, which is an adaption of the basic Bessemer method. Without traversing the details of the process, it is enough to recall that in it there are no means of using the scrap which results from the subsequent rolling of the steel. It may be taken in general that for every ton of steel ingot made and rolled into either plates or bars at least 30 per cent. of it appears as scrap. Hence there is in Germany, a large amount of Thomas scrap to be used up, and that is done by employing it as the greater part of the charge in the open-hearth furnace. In consequence it is not unusual to find the charge consisting of 80 per cent. of scrap and 20 per cent. of pig iron, whereas in Great Britain the usual charge will be 40 per cent. of scrap and 60 per cent. of pig iron. In Germany, therefore, the conditions call for a rapid melting of the scrap, and, when the whole charge is molten, the metallurgical condition in the bath is such that practically no further refining is necessary. In Great Britain, however, and to a large extent in America, the melting of the charge, although an important factor in the total time taken, does not occupy as much time as the subsequent working of the molten material to the necessary degree of refinement.

The difference outlined is of greater moment than may appear from our statement, and has a fundamental effect on the working of a Siemens furnace and consequently upon its design as an engineering structure. We feel, therefore, that, whilst in no wise depreciating the descriptions which the author has given, he would have rendered a great service to the industry if better comparison could have been made between the practice in the three countries mentioned, especially if the determining factor in each case could have been indicated. Furthermore, the interesting illustrations of furnaces which have been developed in Germany would be very much more helpful if the service obtained from each of the types could have been given. It is evident from what we have said already that the conditions under which a furnace is worked has a vital effect upon the service obtained; consequently, however, attractive a particular design may be, it remains only a design unless some data of its performance are given to support its claim for serious consideration.

With these few general remarks we may now touch upon one or two special points in the book which have attracted our attention. We are interested in the reference the author makes to the McKune furnace on page 103, and in passing we may remark that the design with the vertical damper at the mouth of the port, shown on page 104, has been abandoned, and horizontal dampers in the vertical flues adopted as standard design. On page 138 the author introduces the subject of the use of water cooling elements for maintaining the furnace structure, but he has dismissed the matter in a somewhat cursory fashion without giving to it its due weight. We are aware that water cooling has found little favour in Germany and, indeed, in British works; but in America water cooling has been applied to an extreme degree, and whilst the tendency may be to reduce the amount employed, yet in view of the increasingly strenuous demands made upon the open-hearth furnace, which is not being met by an increase in efficiency of the refractories, we fully expect that some measure of water cooling will become standard practice in Europe. The author leaves the vital subject of refractories practically untouched. He may urge that they should be dealt with by experts on refractories; but, granting this, the importance of the right use of refractories and their efficiency in withstanding the high temperatures now common in open-hearth furnaces makes some definite reference to the subject necessary in a book of the character of that under review.

In a section of the volume which deals with thermal efficiency it is mentioned that a large proportion of the heat lost escapes in radiation from the body of the furnace, and it is indicated that efforts have been made to reduce this loss by introducing walls of greater thickness than usual. Some details of the experience resulting from these efforts would have been interesting. The efficiency of the open-hearth furnace increases with an increase in the temperature of the burning gases within it, and the limit of the temperature employed is the capacity of the refractory materials to stand it. At present the silica bricks available have a melting point at about 1800 deg. Cent., and hence the maximum temperature at which it is possible to work is limited to about 1700 deg. Cent. to 1750 deg. Cent., and even at that temperature the surface of

the walls exposed to the heat is on the point of melting. The bricks, therefore, can only stand these extreme conditions by the rapid passage of the heat from the exposed surface through them to the outside air so that the average temperature gradient across the wall comes within a safe limit. Now, if a wall is built of greater thickness there is an increase in the resistance to the passage of heat per unit of time, and consequently the protection afforded to the hot surface is reduced. In practice the experience is that a silica wall will become reduced in thickness by the melting away of the exposed surface until a dimension is arrived at where the rate of passage of heat through the brick and its dissipation in radiation just balances the rate of impression of heat on the exposed surface. When this condition has arisen, as it does do almost automatically, it will be found that the wall will last for a relatively long period unless some increase in the furnace temperature takes place, when automatic readjustment follows.

We are surprised to find that in dealing with open-hearth furnace accessories the author confines his reference to furnace charging machines exclusively to the overhead revolving type. That machine is essentially a German development and expresses something of the national mentality. The German loves a machine, and the more complicated that machine is the greater is his admiration for it. The characteristic shows itself in most German steel works, which invariably suffer from "over engineering." The low ground type charging machine is not mentioned, although it is used universally in America, and largely in Great Britain, and is a very much more simple and rapid working unit than the overhead machine. Speed of operation is the essential factor in these days when big outputs from furnaces often depend upon the saving of a few minutes during charging operations.

We commend to the attention of British steel makers the methods for the heating of ladles described on page 177. They are very much more effective and economical than the usual methods adopted in British shops.

We have touched upon these few points mainly with a view to showing how much there is in this vast subject which needs investigation, but we do not wish our comments to be taken as depreciating the value of the book. Whilst there are many points on which we cannot agree with the author, yet we gladly pay tribute to the excellent work he has done in gathering together so many examples of current practice in this important phase of metallurgical industry. We have read the book with very great interest, and the logical sequence of his treatment of the subject appeals to us. We can recommend it with confidence to all who are interested in open-hearth furnaces and the extensive supplementary plant which the installation of such furnaces demands.

Alternating-current Rectification. By L. B. W. Jolley. London: Chapman and Hall, Limited. Price 25s. net.

We believe that we are correct in saying that this is the first book to be published in this country on rectification. The subject is a very fascinating one, and it is of growing importance. Although we hold the opinion that direct current is often used when alternating current will serve the purpose quite well, it is of course a fact that rectification or conversion by means of rectifiers, rotaries or motor generators is sometimes essential. The author of this book is clearly by no means an out-and-out advocate of direct current, for he says that, however much may be said regarding the advantages of direct current, there is little doubt that at the present time, from the point of view of generation and transmission, alternating current has considerable advantages over direct current. America, he states, points to the absolute necessity of alternating current as the only possible system for the present, and the near future. But it is, of course, perfectly true, as the author himself shows, that direct current must be used for certain purposes, such as for charging accumulators.

The book covers a wide field. The early part is the most theoretical portion of the volume, for it deals with harmonic analysis, a subject which is perhaps more fascinating to mathematicians than to engineers. The author next deals with the most common types of electrical machines which are used for conversion, such as rotary converters and motor converters. These machines, however, are only briefly considered, as they have been dealt with by many other writers on electrical subjects. The book, as the title implies, is concerned more particularly with the mechanical, mercury vapour, thermionic and electrolytic rectifiers, which have passed beyond the experimental stage. Incidentally, the author does not deal at any length with the Transverter, owing, no doubt, to the fact that it has not as yet been put to practical use. Other types of rectifiers with commutators and vibrating reed rectifiers are, however, discussed more fully, but these rectifiers are, of course, only made for small outputs. In many cases the kenetron or thermionic tube has displaced them. Following a chapter on the conduction of electricity through gases, there is a chapter on mercury vapour rectifiers, which is purely theoretical. In the next three chapters, however, there is a great deal of useful practical information on mercury vapour rectifiers, and descriptions of large metal-cased rectifiers as made by Brown, Boveri et Cie. are given. Attention is also paid to smaller glass bulb rectifiers.

One of the most interesting sections of the volume is that which is devoted to thermionic rectification, in which the author shows the method by which thermionic rectification is possible. Gas tube rectifiers, such as the Neon tube, Tungar, and Magneton rectifiers, are then discussed; also plate to point discharge, vibrating flame, corona and photo-electric cell rectifiers. Finally, the author deals with the conduction of electricity through liquids, electrolytic rectifiers, wireless rectifiers and alternating-current measurements and voltage regulation. Considering that rectification is daily becoming a matter of greater importance, and that as far as we are aware information on the subject has never before been brought together in the form of a book, the present volume should, we think, prove very acceptable to a large number of electrical men, especially in view of the fact that it is up to date and covers all rectifiers of practical value.

Wireless Valve Transmitters. The Design and Operation of Small Power Apparatus. By W. James. London: The Wireless Press, Limited. Price 9s.

The author of this book is a well-known writer on wireless matters, and he has been responsible for many articles and several books on wireless receivers. In the present volume, however, he deals with transmitting apparatus such as that used by amateurs. The book is written on very simple lines and should, we think, prove useful to all amateurs who are engaged in experimental work. It is, of course, necessary to obtain a licence from the Postmaster-General before experiments with transmitting apparatus can be carried out, and it is not always easy to obtain permission to use a radiating aerial. But much instructive work can be done with an "artificial aerial," and many problems that arise in connection with work of this kind are dealt with in this book. There is a great deal of useful information, for instance, about the power supply, which often presents difficulties. Descriptions are given of various kinds of rectifiers suitable for wireless transmitting work. Considerable attention is also paid to microphones and speech amplifiers, the three-electrode oscillating valve, transmitting circuits, &c. The circuits dealt with are quite usual and reliable circuits which have proved to be of real practical value. There is no other book, so far as we know, which deals with wireless transmission on such simple and straightforward lines as this new volume, and we have no hesitation in recommending it to amateurs and others who are anxious to gain some knowledge of this branch of wireless communication.

SHORT NOTICES.

Recent Progress in Engineering Production. By C. M Linley. London: Ernest Benn, Limited. 1924. Price 42s. net.—Let us say at once that the title of this book does not properly describe the contents. It would lead one to suppose that the author discussed production methods from the broad view. He does not do anything of the kind, but gives brief descriptions of both and appliances in many cases, both as regards text and illustrations, drawn direct from manufacturers' catalogues. We find relatively little original work in it, and the treatment is distinctly out of balance. It is obviously, for example, quite impossible to deal with modern milling machines and milling practice in sixteen or seventeen pages of which the bulk of the area is occupied by tone cuts from catalogues. All subjects suffer from the same cause: some machines are mentioned, whilst others of equal merit are neglected. Barely five pages are given to drilling machines, with the consequence that nearly all the important machines and makers are neglected. In the chapter devoted to lathes several American machines are described, but one is left wondering if the author has ever heard of British lathes. The volume gives the reader the impression that the author has taken written and "pasted-up" pages from his common-place book and strung them together into a volume.

Tables of Steel Compound Girders. Compiled by F. B. Mason. London: Chapman and Hall, Limited. 1924. 10s. 6d. net.—For many years Mr. Mason was chief draughtsman and structural designer with Dorman, Long and Co., Limited, in London. He prepared a complete set of tables, covering the latest British standard beam and the British standard beams of 1904. We presume that, following the practice in drawing-offices, these tables were neatly drawn out on tracing paper, and that blues were printed off as required. In this volume the originals have been reproduced as blocks 4¼in. by 6¼in., but they are quite legible. Each table gives the essential particulars for one or two beams, first the dimensions, and then the properties. There are, of course, many tables of beams, but probably this series, prepared for drawing-office use, will appeal particularly to draughtsmen.

Carburation in Theory and Practice. By Robert W. Brewer. London: Crosby Lockwood and Son. 1924. Price 15s. net.—This is the third edition of a book which is fairly well known amongst automobile engineers. It may be divided into three parts. In the first, we have a dozen chapters dealing with the principles of carburation and carburetters, in the second, one long chapter in which carburetters are described; and in the third, a number of appendices. The volume has been brought as much up to date as possible, but the author tells us in a note that he "has written a new book dealing with some of those problems of thermal economics which now face the automobile engineer and the user."

French-English, English-French Dictionary of Financial Terms and Phrases. By J. O. Kettridge. London: George Routledge and Sons, Limited. 1924. Price 10s. 6d. net.—This is quite a useful dictionary for the general office. We have tested it here and there, and find it well done. On the title-page it is stated that twenty-five thousand words, terms and phrases are translated and illustrated by numerous examples. The arrangement is good and the printing clear.

BOOKS RECEIVED.

Hütte des Bauingenieurs. 24 *Auflage.* Berlin: Wilhelm Ernst and Sohn, Wilhelmstrasse, 90.

The Merchant Navy. Vol. II. By A. Hurd. London: John Murray, Albemarle-street, W. 1. Price 21s. net.

Mining Educator. Part I. Edited by J. Roberts. London: Sir I. Pitman and Sons, Limited. Price 1s. 3d. net.

The Failure of State Railways. By H. Cox. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 6d.

The Fatigue of Metals. By H. J. Gough. London: Scott, Greenwood and Son, 8, Broadway, Ludgate-hill, E.C. 4. Price 25s. net.

SIXTY YEARS AGO.

In a leading article in our issue of November 25th, 1864, we discussed the question of boiler explosions. "Can," it was asked, "a boiler explosion be termed an accident? Would a jury, composed of twelve competent engineers, decide that boiler explosions are casualties? We should say that few engineers—and no engineer who had considered the matter—would assert that boiler explosions cannot be prevented by skilled attention. Men, professionally trained, may be said to have a strong feeling on this matter, and no eloquent barrister, charm he ever so wisely, could persuade such men that boiler explosions are not preventable. Given the case of any boiler on the point of bursting:—Let the fires be drawn, the water blown out, and the shell cooled down; let the hydraulic test be applied; send a practical man inside; and the fact that the boiler was on the point of bursting could be certainly predicted by such an examination. A boiler explosion is, in truth, no more an accident than when a man sits on a barrel of gunpowder, and lets a match drop down the spigot hole. And yet the law in this country, as it stands at present, practically regards a boiler explosion as a casualty—as something like an earthquake, or storm, or apoplectic stroke. In cases of death through boiler explosions, juries generally return a verdict of accidental death. Except in cases where very gross negligence can be distinctly sworn to, persons injured by such an occurrence as a boiler explosion have, practically speaking, no remedy. The explosion has destroyed the greater portion of its own evidence, and, likely enough, the most important human witnesses have been silenced in the same way. It is probable that more than enough property is annually destroyed by boiler explosions than would suffice to support a number of men, equal to the number of the annually killed, while engaged in inspecting all the boilers throughout the kingdom." The concluding sentence is not quite faultless in grammar, and lacks in clearness of expression, but its meaning is fairly evident. . . . In the same issue was given an account of the trial of a "new machine for getting coal" which had been recently carried out at the Kippax colliery, near Leeds. The machine, which had been made by Messrs. Carrett and Marshall, of Leeds, was described as being quite different from other machines previously tried, inasmuch as whilst the latter were operated by compressed air and on the principle of the pick motion, the former was worked by water pressure at 150 lb. per square inch and had a to-and-fro motion. The trial was made in the Allerton seam of coal, which was 5ft. 6in. thick, but contained a layer of dirt 3in. thick at the height of 20in. from the floor. The machine was mounted on four wheels and traversed on the corf tramways. The "holing" or "boring" is described as having been done remarkably well in one even straight line and to a uniform depth. The cutters were fixed in a slotting bar, which worked with a steady longitudinal reciprocating motion at a slight angle, which ripped out the whole of the partition of dirt to a depth of 3ft 3in "at once going over." The apparatus was entirely self-acting in all its operations. It propelled itself forward, "secured itself dead fast between the floor and the roof, while the cutters were in operation, and again released itself with the return stroke, making twenty-five strokes per minute."

Obituary.

ROBERT BOLTON RANSFORD.

The death is announced, as having taken place on Saturday last at a nursing home, of Mr. R. B. Ransford, a well known patent agent and partner in the London firm of Carpmaels, Ransford and Newton, chartered patent agents, of Southampton-buildings, London, W.C. Mr. Ransford, who was in his fifty-sixth year, although not himself an engineer, had had a wide experience of engineering and electrical matters and machinery, and was an Associate of the Institution of Civil Engineers. He was educated at Dulwich College and at Jesus College, Cambridge, from which he graduated as 27th Wrangler. He was president of the Chartered Institute of Patent Agents in 1919–21, and had been for many years vice-chairman of the Board of Governors of his old school, having been nominated a member of that body by the London County Council. He was also a Justice of the Peace. He will be greatly missed in the profession to which he belonged, and to the members of which he was endeared by his ability and a rare charm of manner.

Marine Oil Engine Trials Committee.

TRIALS OF THE MOTOR SHIP SYCAMORE.

THE Marine Oil Engine Trials Committee dates its origin from 1922, when Mr. D. B. Morison offered to place at the disposal of the Institutions of Mechanical Engineers and Naval Architects a 6000-ton deadweight capacity oil-engined vessel for which his firm, Richardsons, Westgarth and Co., Limited, were building the machinery. The offer was accepted and a committee of the two Institutions was duly formed. Representatives of the Admiralty and of the Institute of Marine Engineers were added to the committee, and Sir George Goodwin was appointed chairman and Mr. W. H. Patchell deputy chairman.

On Friday evening of last week the Committee presented its first report at a joint meeting held at the home of the Mechanical Engineers in London. The report, a lengthy document of over 120 pages, covers the Committee's tests on the motor ship Sycamore, the vessel referred to by Mr. Morison when he made his offer. This vessel was built by the Furness Shipbuilding Company for Messrs. Furness, Withy and engined by Messrs. Richardsons, Westgarth. She has a length between perpendiculars of 363ft., a moulded breadth of 52ft., and a mean draught of 23ft. when fully loaded. Her displacement fully loaded is 9200 tons and her deadweight capacity 6000 tons. An estimated service speed of 11.5 knots was designed to be secured by two sets of oil engines, each driving a separate shaft and screw and developing a total of 2500 shaft horse-power. These engines are of the Richardsons-Beardmore-Tosi director valve type. They run nominally at 125 revolutions per minute. Each has six cylinders working on the four-stroke single-acting cycle.*

The following is a table of the weight of machinery in the engine-room :—

TABLE I.—*Weight of Machinery in Engine-room.*

Part.	Weight, tons.
Main engines, complete with all pipes and fittings, including thrust blocks, but excluding fly-wheels	426.5
Fly-wheels	24
Shafting and stern gear	42
Auxiliaries, pipes and fittings—	
Fuel oil system	21
Lubricating oil system	20
Starting air system	41
High-pressure air system	2.1
Exhaust system	32
Cooling water system	17
Pumping system (bilge, ballast and sanitary pumps)	18
Electric generator system	32
Steam system (boilers, condenser, oil burners, &c.)	69.7
Fittings on board—Ventilators, gratings, workshop, lifting gear, tools and outfit	43.7
Spares—Main engine and auxiliaries	33
Total	822.0
Water in system	4
Water in boilers	16
Water in fresh water tank	35
Lubricating oil in system	14
Total	69.6
Total running weight	891.0

It may perhaps be noted that the main engines alone weigh 382 lb. per shaft horse-power, while if we include the additional items in the table down to the eighth—cooling water system—the weight is 560 lb. per shaft horse-power.

The average stroke of the pistons is given in the report as 38.3891in. and the average bore as 24.4095in. The clearance volume is stated to be 1495.8 cubic inches, the volume swept through by each piston per stroke 10.396 cubic feet, and the ratio of compression 13.016.

TESTS ASHORE.

The port engine was tested at Richardsons, Westgarth's works during seven days in July, 1923. The conditions under which the engine was tested were arranged to imitate as closely as possible those under which the engine might be called upon to work at sea. To this end a simple approximate propeller law was assumed, namely, that for a given depth of immersion in water and a given slip the torque of a propeller was proportional to the slip multiplied by the square of the speed in revolutions per minute. Assuming constant slip, the engine speed was calculated by this formula for the torques at full, three-quarters, half, and quarter power, or, to be more exact, for the nearest values of these torques which the available brake loads would give. In addition to carrying out tests at the speeds thus arrived at the engine was tested at 15 revolutions per minute above and 15 revolutions per minute below the calculated speed for each torque in order to imitate its performance when propelling the ship in light draught during fine weather and when heavily loaded in bad weather.

* An illustrated account of the Beardmore-Tosi director valve type of engine will be found in our issue of November 11th, 1921. One of its principal features is the fact that each cylinder head carries two valves, both of which act alternately as inlet and exhaust valves. An oscillating "director" valve is employed to open communication alternately with the suction and exhaust pipes.

The following table gives the torques, brake loads, and speeds as thus determined.

TABLE II.

Applied external load.			Speed (R.P.M.).		
			A.	B.	C.
Nominal.	Torque.	Nearest brake load.	Calculated from propeller law.	High speed.	Low speed.
	Lb.-ft.	Lb.			
Full torque ..	52,500	4,000	125	140	110
¾ torque ..	39,375	3,000	108	123	93
½ torque	26,250	2,000	87	102	72
¼ torque	13,125	1,000	63	78	48

In carrying out the tests the procedure followed was

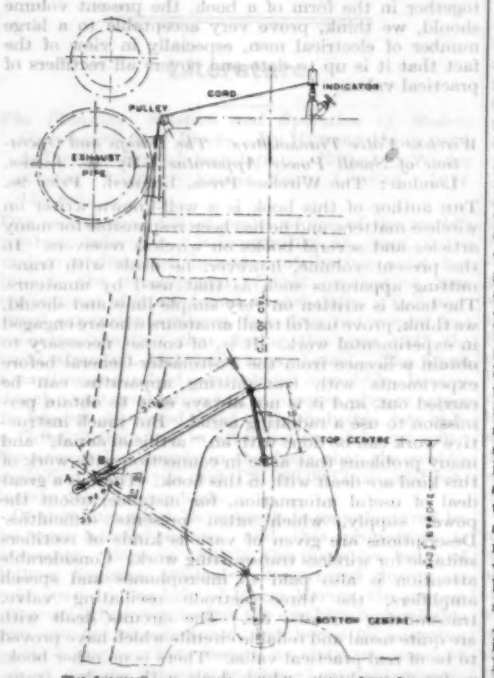


FIG. 1—SHORE TEST INDICATOR RIG

to arrange the brake load to give a desired torque and then to adjust the speed as closely as possible to that given in column C. After a period for stabilisation the test was started. On its completion the speed was readjusted until it was raised to that in column B. A further stabilising interval was allowed before the readings were taken. Finally the tests at the speed given in column A were made. The three tests at each torque were completed in one day.

Brief details of the testing apparatus used may be given before we pass on to summarise the results obtained. The quantity of fuel passing to the engine was measured directly by means of an Avery weighing machine fitted with a tank holding sufficient fuel for an hour's full-load run. In order to check the steadiness of the consumption intermediate weighings were made every five or ten minutes. The brake used was an absorption dynamometer made by Heenan and Froude, designed to measure a maximum of 2300 brake horse-power at 110 to 180 revolutions per minute. It had a brake arm of 13ft. 1⁹⁄₃₂in. radius and weights of 200 lb. each. On the different pressure lines about the engine Bourdon gauges by Dewrance and Co. were fitted, the gauges on the more important pressures being calibrated by means of a deadweight tester. The thermometers employed were mostly manufactured by Casartelli and Sons, and at important points were calibrated by the Committee. A "Cambridge" iron-constantin thermo-couple, in addition to a high temperature mercurial thermometer, was placed in each exhaust pipe behind the director valve and at the funnel end of the exhaust manifold. The revolution counter was of the standard "Harding" type. The condition of the air induced into the engine was determined by a dry and wet bulb hygrometer placed close to the aft end of the induction manifold. The atmospheric pressure was read from a "Fortin" barometer situated about 100 yards from the test shop. "Maihak" external spring type Diesel engine indicators were used on the engine cylinders, the drive being effected, as shown in Fig. 1, by means of a cord passing over a pulley on the cylinder head from a link gear attached to each crosshead. Cards were taken every half-hour. It is noted in the report that the drive to the indicators on the different stages of the injection air compressor was not particularly satisfactory and that the cards obtained will not probably bear close analysis.

The water in the cooling circuits was measured by means of four Glenfield and Kennedy hot water meters arranged, as shown in Fig. 2, in the jacket and exhaust manifold circuit, the pistons circuit, the heads and valves circuit, and the air compressor and coolers circuit. No water was passed through the crosshead guides circuit. The cooling water used was fresh and was itself cooled by means of salt water, the rate of discharge of which from the cooler was measured by means of an orifice tank. The salt water discharge rate thus arrived at is not regarded as trustworthy. Samples of the exhaust gas were withdrawn from the manifold into glass containers by allowing mercury inside the containers to dribble slowly away over the space of an hour. The containers were hermetically sealed for analysis later. An unfortunately long interval, however, occurred between the sampling and analysing, and it was found that changes had taken place in the composition of the samples chiefly as a result of the absorption of carbon dioxide in the rubber sealing caps of the containers. The analyses were therefore subjected to a process of adjustment before they were made use of in the thermal balance sheet. The fuel used was Anglo-Persian Diesel oil. As analysed at the Greenwich Fuel Research Station it had an average gross calorific value of 19,320 B.Th.U. per pound. From its composition it was calculated that the combustion of 1 lb. of fuel should yield 3.11 lb. of carbon dioxide and 1.10 lb. of steam and would require theoretically a total weight of 13.90 lb. of air. Three qualities of lubricating oil were used, one for the crank case, one for the air compressor cylinders, and one for the power cylinders.

SHORE TEST RESULTS.

The results of the tests ashore are set out in the original report in nineteen tables and fourteen diagrams. They are not summarised nor discussed in any way and no comparative or controversial matter is introduced. The tables are summarised in Table III. herewith. Table IV. gives the thermal balance sheets. It will be understood that the letters B, A, C above the test numbers relate respectively to the over-speed, normal speed, and under-speed tests carried out at each value of the torque, as set forth in Table II. Test No. 15 was an additional full-power test carried out after the builders had advanced the timing of the fuel valves, an adjustment which had the effect of raising the firing pressure from 590 lb. to 606 lb. per square inch, and of reducing the fuel consumption. With this exception the tests were all run without the engine adjustments being altered or touched.

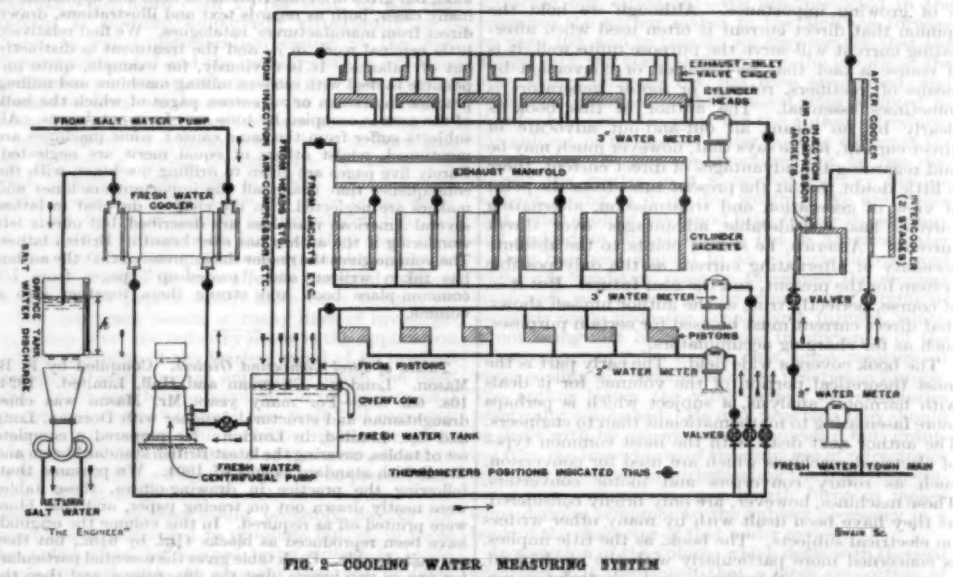


FIG. 2—COOLING WATER MEASURING SYSTEM

MARINE OIL ENGINE TRIALS COMMITTEE.

TABLE III.—*Shore Trials of Port Engine.*

Test number :	A 15	B 4	A 5	C 3	B 7	A 8	C 6	B 10	A 11	C 9	B 13	A 14	C 12
Average speed, r.p.m.	123.18	134.17	118.81	104.68	121.10	105.20	90.47	101.37	85.37	71.82	75.43	60.03	44.67
Load on brake, lb.	4,000	4,000	4,000	4,000	3,000	3,000	3,000	2,000	2,000	2,000	1,000	1,000	1,000
Fuel per minute, lb.	8.727	10.175	8.955	7.823	7.090	6.088	5.433	4.400	3.687	3.233	2.227	1.780	1.323
Fuel per B.H.P. per hour, lb	0.425	0.455	0.452	0.448	0.469	0.463	0.481	0.517	0.518	0.540	0.708	0.712	0.709
Fuel per I.H P. per hour, lb.	0.339	0.348	0.352	0.345	0.335	0.322	0.341	0.333	0.331	0.337	0.332	0.344	0.350
Brake horse-power	1,232	1,342	1,188	1,047	908	789	678	507	427	359	189	150	112
Brake M.E.P., lb. per sq. in.	73.5	73.5	73.5	73.5	55.1	55.1	55.1	36.7	36.7	36.7	18.4	18.4	18.4
Pressure, lb. per sq. in.—													
At end of compression	461	455	452	456	457	458	460	460	456	455	456	459	452
Maximum during firing	606	557	590	586	479	500	540	476	490	525	412	428	421
At end of expansion	38	37	37	35	30	30	30	27	25	23	17	16	15
M.I.P., Average all cylinders	91.9	96.0	94.4	95.6	77.3	79.2	77.7	57.4	57.6	58.8	39.2	38.0	34.3
Indicated horse-power	1,542	1,753	1,527	1,360	1,271	1,134	957	793	668	576	402	310	209
Exhaust gas temperature, deg. Fah., average at exit from cylinders	601	650	598	573	526	485	451	390	361	343	276	252	233
Total I.H.P. of compressor	86.3	112.0	96.0	71.0	90.5	74.4	63.8	67.3	56.8	47.7	37.7	30.0	20.6
Blast air pressure, lb. per sq. in.	1,013	1,063	1,023	863	913	863	863	763	763	763	543	543	513
Blast air temperature, deg. Fah.	93	91	93	83	86	85	84	78	80	76	69	70	75
Cooling water, cylinder jackets and exhaust manifold, quantity per hour, gallons	5,208	6,640	4,705	6,670	4,290	3,720	9,280	5,490	a	5,709	2,060	1,980	a
Heat rejected to jackets, B.Th.U. per minute	18,400	21,040	18,250	19,900	14,100	14,870	15,150	10,790	—	10,550	6,380	6,840	—
Heat rejected to manifold, B.Th.U. per minute	17,100	19,600	17,950	15,230	12,890	7,580	11,150	8,052	—	2,945	2,710	2,575	nil
Cooling water, cylinder heads and valves, quantity per hour, gallons	3,110	3,730	3,545	3,290	2,740	2,463	2,580	1,810	1,585	1,610	1,250	1,240	1,080
Heat rejected to heads, &c., B.Th.U. per minute	20,700	22,920	21,220	19,540	16,210	14,650	12,950	9,900	8,610	7,165	4,080	3,700	3,490
Cooling water to pistons, quantity, gallons per hour	713	1,120	935	990	770	720	880	1,140	1,870	1,130	730	700	—
Heat rejected to pistons, B.Th.U. per minute	5,500	6,920	6,320	6,040	4,810	4,920	5,260	4,370	8,120	4,200	2,740	2,610	—
Cooling water to air compressor and coolers, quantity per hour, gallons	2,060	2,040	2,017	2,070	2,540	2,450	2,330	2,390	4,640	2,390	2,300	2,360	2,330
Heat rejected to compressor, &c., B.Th.U. per minute	4,080	5,140	4,670	3,860	4,440	3,840	3,700	3,180	6,340	2,790	1,990	1,890	1,590
Mean specific heat of dry exhaust gas, B.Th.U. per lb. per deg. F. b	0.2364	—	0.2349	—	0.2348	—	—	—	—	0.2333	—	0.2337	—
For 1 lb. of carbon in fuel—													
Weight of dry exhaust gas b	34.7	—	30.7	—	41.7	—	—	—	—	50.0	—	65.4	—
For 1 lb. of fuel consumed—													
Weight of dry air induced b	29.52	—	26.13	—	35.47	—	—	—	—	42.50	—	72.52	—
Weight of air in excess of that required for combustion b	15.62	—	12.23	—	21.57	—	—	—	—	28.60	—	58.62	—
Total amount of heat carried away in exhaust gas, B.Th.U. b	41,688	47,032	37,982	30,843	32,922	25,700	24,041	16,066	13,378	11,449	9,440	6,906	3,843
Mechanical efficiency	79.8	76.6	77.8	77.0	71.5	73.2	71.0	64.0	63.9	62.4	46.9	48.4	53.4
Thermal efficiency, B.H.P. basis	31.1	28.9	29.1	29.4	28.1	28.4	27.4	25.3	25.4	24.4	18.6	18.5	18.6
Thermal efficiency, I.H.P. basis	38.9	37.9	37.5	38.2	39.4	39.0	39.6	39.6	39.9	39.5	39.8	38.4	34.6
Efficiency of ideal engine	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0
Efficiency ratio	0.748	0.729	0.722	0.735	0.758	0.750	0.762	0.762	0.768	0.760	0.766	0.738	0.666
Friction horse-power	224	278	265	252	242	226	213	192	178	166	140	130	114
Volumetric efficiency, per cent. b	82.5	79.2	78.5	77.1	82.8	82.0	85.0	73.0	72.6	75.2	84.0	85.0	85.0

a The water quantities, as recorded, are inadmissible. b The quantities thus marked are influenced by probable errors in the analysis of the exhaust gases.

TABLE IV.—*Thermal Balance Sheets.*

(All quantities in B.Th.U. in respect of one minute's duration.)

Test number :	A 15	B 4	A 5	C 3	B 7	A 8	C 6	B 10	A 11	C 9	B 13	A 14	C 12
To heat carried in by fuel (gross)	168,600	196,600	173,000	151,000	137,000	117,600	105,000	85,000	71,200	62,400	43,000	34,400	25,600
By thermal equivalent of—													
Brake horse-power	52,220	56,900	50,400	44,400	38,500	33,430	28,740	21,500	18,100	15,220	8,020	6,360	4,750
Compressor horse-power	3,660	4,720	4,050	3,020	3,840	3,155	2,700	2,850	2,410	2,020	1,600	1,280	875
Friction horse-power	9,500	11,780	11,240	10,680	10,260	9,580	9,040	8,140	7,550	7,040	5,940	5,520	4,830
By heat rejected to—													
Jackets	18,400	21,040	18,250	19,900	14,100	14,870	15,150	10,790	—	10,550	6,380	6,840	—
Manifold	17,100	19,600	17,950	15,230	12,890	7,580	11,150	8,055	—	2,945	2,710	2,575	nil
Heads	20,700	22,920	21,220	19,540	16,210	14,650	12,950	9,900	8,610	7,165	4,080	3,700	3,490
Pistons	5,500	6,920	6,320	6,040	4,810	4,920	5,260	4,370	8,120	4,200	2,740	2,610	nil
A.C. jackets and coolers	4,080	5,140	4,670	3,860	4,440	3,840	3,700	3,180	6,340	2,790	1,990	1,890	1,590
*By heat in dry exhaust gas	41,688	47,032	37,982	30,843	32,922	25,700	24,041	16,066	13,378	11,449	9,440	6,906	3,843
*By total heat of superheated steam													
By radiation and unaccounted for	4,248	+548	+918	−2,513	−972	−125	−7,791	+149	—	−979	+100	−3,281	—
Total	168,600	196,600	173,000	151,000	137,000	117,600	105,000	85,000	71,200	62,400	43,000	34,400	25,600

* These quantities are influenced by probable errors in the analysis of the exhaust gases.

Some additional tests of a minor nature were carried out on the engine while in the test shop. Of those tests the most interesting probably was one made with the object of determining the temperature of the metallic parts of the engine exposed to combustion. By means of four different fusible alloys the following temperatures were found to prevail in the parts named during the six-hour full-power trials :—

Piston crown	Above 446 deg., below 626 deg. Fah.
Exhaust inlet valve head	Above 788 deg., below 960 deg. Fah.
Exhaust inlet valve seat	Above ?, below 626 deg. Fah.

A lubricating oil consumption test should also be noted. It was found that at 120 revolutions per minute the power cylinders used 3.1 gallons of lubricating oil per day and the air compressor 1.5 gallon.

SEA TRIALS.

The trials of the vessel at sea were carried out during two days in April, 1924, while the vessel was on a passage from Swansea to the Mersey. The wind and sea conditions are given as good throughout the trial. On leaving Swansea the vessel had on board cargo, fuel, stores, and water to the aggregate amount of 3755 tons, the draught being 17.4ft. forward and 20.8ft. aft. In this condition the vessel had a total displacement of 7425 tons.

The trials were carried out at full engine speed—125 revolutions per minute nominal—and at what was likely to be the speed of the vessel on service, namely, 105 revolutions per minute nominal. The full-speed trial was made in the Bristol Channel and extended over a period of four hours. During it the wind was nearly ahead and had a velocity of about 12 knots. The reduced-speed trial was made in the Irish Sea and lasted for three hours. In this case the wind was nearly astern and had a velocity of about 15 knots. The speed of the ship was measured by means of a Walker log towed about 200ft. abaft the ship. This log had previously been calibrated on a similar ship during twelve measured mile runs. At full revolutions the speed of the Sycamore was found to vary between 11.6 and 12.2 knots, according as the wind shifted. At the reduced speed setting the log registered 10.2 to 10.3 knots.

Every half-hour throughout each trial records were made of the revolutions of both engines, the levels in the fuel tanks and the temperatures about the engines. The engine speeds were adjusted so that, with no helm on the ship, the average revolutions should be as near as possible 125 and 105 per minute in the two trials respectively. This condition resulted in the following engine speeds :—

Trial	I.	II.
Engine	Port .. Stb'd	Port .. Stb'd
Average r.p.m.	127.9 .. 124.8	106.4 .. 104.4

Indicator cards were taken from the power cylinders every half-hour and from the air compressor at the intermediate quarter-hours.

With regard to the measurement of the fuel consumption it is to be noted that the total was measured under three heads, viz., (*a*) the amount supplied to the main engines jointly ; (*b*) the amount supplied to the steam boilers for the evaporator and other auxiliary purposes ; and (*c*) the amount supplied to a two-cylinder "Tosi" engine driving an electric generator for lighting and certain other auxiliary purposes. The main engine supply was measured in a calibrated tank consisting of two cylinders mounted on a common box-form base. A vertical gauge glass was disposed symmetrically between the cylinders so that the level indicated in the glass was the mean of the levels in the two tanks and was not affected by any movement of the ship. While this arrangement gave good results, it did not permit the fuel supply to each main engine to be measured separately. To apportion the total supply between the two main engines it was assumed (*a*) that each would take a quantity proportional to the power it developed and, as an alternative, (*b*) that the supply to each was a linear function of the exhaust gas temperature. These two methods yielded the following results for the fuel consumption in pounds per hour :—

Trial	I.		II.	
Method	(*a*)	(*b*)	(*a*)	(*b*)
Port engine	506	503	301	297
Starboard engine	535	558	330	333

The averages of these values were taken. As regards the supplies to the boilers and generator engine it is noted in the report that oscillations in the measuring device employed reduced the value of the readings obtained.

In addition to the fuel and other measurements detailed above the torque and thrust developed were directly measured. The torques were determined by means of a "Moullin" torsionmeter on the port shaft and a Hopkinson-Thring torsionmeter on the starboard shaft. The thrust was measured by means of a recording oil ram arrangement—see Fig. 3—obtained from Michell Bearings, Limited, and applied to the thrust block of the starboard shaft. The thrust of the port shaft was not measured.

The fuel used as tested after filtration in the settling tanks had a gross calorific value of 19,080 B.Th.U. per pound, and in its analysis did not differ greatly from the fuel used in the tests ashore.

In the original report the results of the trials and

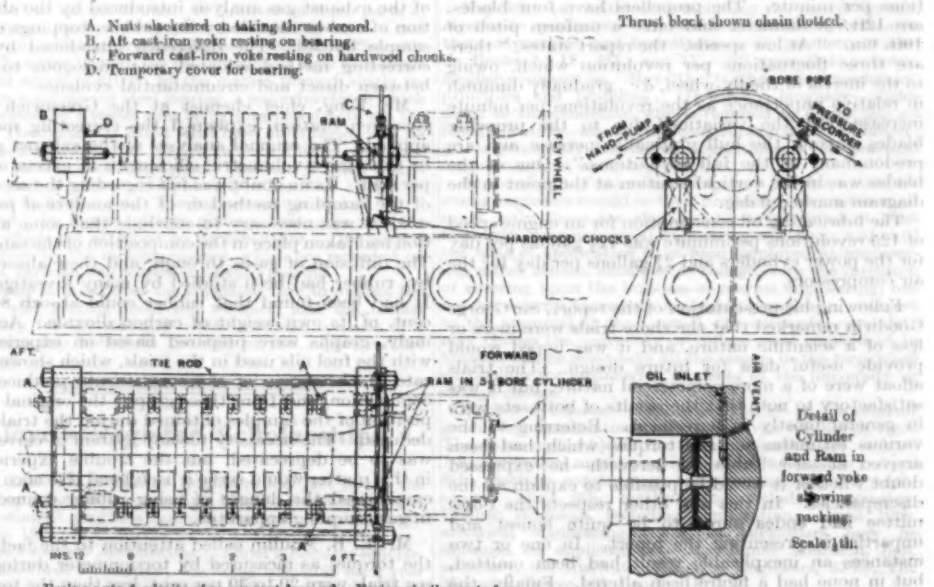

A. Nuts slackened on taking thrust record.
B. Aft cast-iron yoke resting on bearing.
C. Forward cast-iron yoke resting on hardwood chocks.
D. Temporary cover for bearing.
Thrust block shown chain dotted.
RAM
FLY WHEEL
HARDWOOD CHOCKS
BORE PIPE
FROM HAND PUMP
TO PRESSURE RECORDER
AFT
FORWARD
TIE ROD
RAM IN 5" BORE CYLINDER
OIL INLET
AIR VENT
Detail of Cylinder and Ram in forward yoke showing packing.
Scale 1/4th.
INS. 12 0 1 2 3 4 FT.
Easing nuts A admits of movement forward. Easing similar nuts fore side of lugs admits of movement aft.
"THE ENGINEER"

FIG. 3—MICHELL THRUST MEASURING DEVICE

the deductions therefrom are set out in numerous disconnected tables. Below we give a summarised collection of them.

TABLE V.—*Sea Trials of the T.S.M.V. Sycamore.*

Trial I., 4 hours at 125 revolutions per minute nominal.
Trial II., 3 hours at 105 revolutions per minute nominal.

Trial.	I.		II.	
Engine.	Port.	Starboard.	Port.	Starboard.
Average r.p.m.	127.0	124.8	106.4	104.4
I.H.P.	1488	1627	980	1053
Maximum pressure	482	493	486	499
Pressure at end of compression	456	445	453	443
Pressure at end of expansion	34	36	24	25
Average M.I.P.	86	95.8	66.3	74.1
Mechanical efficiency[1]	74	77.5	66.5	69.8
Shaft horse-power	1,100	1,260	638	733
Torque equivalent to S.H.P.[2]	45,500	52,900	31,500	36,800
Torque measured	37,640	40,870	24,170	27,040
Thrust in lb.	—	23,550	—	16,480
Torque equivalent to thrust[3]	47,100	44,600	34,200	32,200
Fuel consumption[4]	8.42	9.28	4.97	5.54
Injection air pressure	933	970	864	914
Exhaust gas temperature, deg. Fah.[5]	570	602	383	403
Compressor I.H.P.	92.8	86.4	82.6	81.0

[1] Deduced from curve obtained during shore trials of port engine connecting mechanical efficiency with mean indicated pressure. [2] In pounds-feet. [3] Calculated from thrust measurement and screw efficiency, the latter being determined from model experiments. The pitches of the two full-size screws being found to be exactly equal, the torques equivalent to thrusts for the port engine were calculated from the starboard engine thrusts on the assumption that the port and starboard thrusts would bear the same ratio to each other as the thrust registered during the model experiments for the same change of slip. [4] In lb. per minute. [5] Average value at the exits of the six cylinders.

It is explained in the report that the torque as measured by the torsionmeter should exceed the torque equivalent to the thrust by about 2 per cent., representing the loss in the tail shaft and journal bearings. It is also explained that the torque equivalent to the shaft horse-power should exceed the torque equivalent to the thrust by the amount necessary to overcome the friction of the thrust block and five journal bearings on each shaft. It cannot be said that the figures given reflect these agreements even approximately.

The thrust meter being of an automatic recording type, permitted a record to be obtained of the variation of thrust during single revolutions of the shaft to which it was applied. Such a diagram is given in Fig. 4. The curve *a* represents the thrust variation during one revolution at 123 revolutions per minute. Two consecutive revolutions at 107 revolutions per minute are represented at *b* and *c*. Curve *d* shows the thrust variation during one revolution at 96 revolutions per minute. The propellers have four blades, are 12ft. in diameter and have a uniform pitch of 10ft. 6in. "At low speeds," the report states, "there are three fluctuations per revolution which, owing to the inertia of the fly-wheel, &c., gradually diminish in relative importance as the revolutions per minute increase, but the variations due to the propeller blades passing the hull gradually increase and are predominant at the full revolutions." One of the blades was in the vertical position at the point in the diagram marked 0 deg.

The lubricating oil consumption for an engine speed of 125 revolutions per minute was 12½ gallons per day for the power cylinders and 2½ gallons per day for the air compressors.

Following his presentation of the report, Sir George Goodwin remarked that the shore trials were more or less of a scientific nature, and it was hoped would provide useful data for future design. The trials afloat were of a more commercial nature, but it was satisfactory to note that the results of both sets were in general mostly in agreement. Referring to the various estimates for the torques which had been arrived at—see Table V. herewith—he expressed doubt whether it would be possible to explain all the discrepancies. In this and other respects the Committee had endeavoured to be quite honest and impartial in presenting the report. In one or two instances an inexplicable result had been omitted, but in none had a figure been altered. Finally, the Committee had aimed at making no comparison and at avoiding any statement of merit or fault.

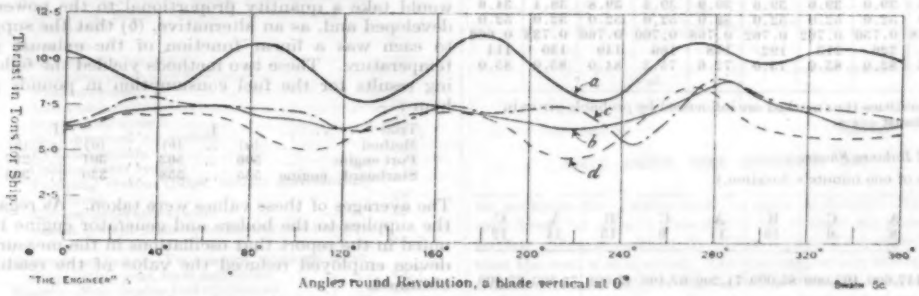


FIG. 4—THRUST VARIATION DIAGRAM

Mr. Tom Westgarth was called upon to open the discussion. After expressing his own and his firm's appreciation to all concerned with the trials and the report, he explained that the Sycamore was a special type of vessel built for the Danube trade. She had relatively shallow draught and had to be exceedingly handy in her manœuvring qualities, a requirement which led to the installation of twin-screw engines. The machinery weights were undoubtedly very great, but there were reasons for that fact. The ship and her sister vessel, the Tramore, were the first of their type to be fitted with Richardsons-Beardmore-Tosi engines, and it was agreed that no risks should be taken by cutting down weights. During the design stage three years ago, there was much discussion as to whether the deck machinery should be driven electrically, but it was eventually decided to use steam for this purpose, as well as for some of the engine-room auxiliaries, in order that the ship's engineers should not be put to too great a change all at once. Again, it was decided to allow a considerable margin in the size of all the pumps and other adjuncts, and as a natural consequence they had to install large sized boilers. Altogether, he estimated that by adopting electrically driven auxiliaries and other expedients, it would have been possible to reduce the 891 tons total running weight of the machinery in the engine-room to 785 tons. A considerable weight of fresh water had to be carried in the vessel for use in the pistons and cylinder covers, when the vessel was in waters such as the Danube, which were liable to give trouble from sand.

Mr. Harvey, superintendent engineer to the owners of the Sycamore, gave a few particulars of the company's sister ship Tramore, which, he said, had a speed of 11.7 knots when the engines were developing 2738 indicated horse-power and running at 120.8 revolutions per minute. Under these conditions the fuel consumption was 0.322 lb. per indicated horse-power per hour, which showed a slight improvement on the performance of the Sycamore. He said that shipowners were rather embarrassed just now by the fact that there were on the market some thirty different kinds of Diesel engine, and it was consequently very difficult for them to decide which type to adopt. They consequently looked forward to the complete results of the trials being carried out by the Committee as settling which was the best type of engine for their purposes. His company now had several vessels fitted with oil engines, with the running of which they were very gratified, and he hoped in the future to be able to give the Institution some particulars of their running in actual trading conditions. Mr. Harvey thought that too much importance was often attached to the fuel consumption of oil engines afloat, as a reduction in the consumption might be attained only by a sacrifice of other desirable features.

Dr. Cecil H. Lander dealt with the deficiencies of the exhaust gas analysis introduced by the absorption of carbon dioxide by the rubber stoppings of the sample bottles. The difference introduced by the correcting method adopted was analogous to that between direct and circumstantial evidence.

Mr. King, chief chemist at the Greenwich Fuel Research Station, explained the correcting method applied. The original analyses of the exhaust gases, he said, gave volumetric efficiencies in excess of 100 per cent. As no doubt was felt regarding the accuracy of the sampling method or of the analytical process used, it was necessary to conclude that some alteration had taken place in the composition of the samples. The diffusion of gases through, and their absorption by, rubber had been studied by many investigators. It had been found that rubber could absorb 80 per cent. of its own weight of carbon dioxide. Accordingly, graphs were prepared based on experiments with the fuel oils used in the trials, which showed the rate of absorption of the constituents produced by combustion, and from these graphs the original composition of the samples obtained during the trials was deduced. The necessity for any system of correction was to be deprecated, but the trouble experienced in this matter would serve a useful end if it once more emphasised the danger of using rubber connections in gas sampling apparatus.

Mr. E. B. Moullin called attention to the fact that the torques as measured by torsionmeter during the sea trials were 20 to 30 per cent. less than the torques predicted from the shore trial results. There was apparently a loss of from 10 to 17 per cent. in the torque between the fly-wheel and the propeller, and he would suggest that this loss was produced by reason of the mechanical efficiency being less at sea than on shore. During the full-power trial at sea the torque registered on the port shaft by his torsionmeter fell from 39,000 lb.-ft. at the beginning to 35,000 lb.-ft. at the end, the value given in the report, 37,640 lb.-ft., being the mean. For less than a minute it rose to 45,000 lb.-ft.—the value predicted from the shore trial results. During the low-power trial the torque registered was steady all through at 24,000 lb.-ft. He thought it was possible that the true performance of the engines might be masked by taking mean values of the observed figures, and he would like to have the extent to which the observed figures departed from the mean given in all cases. As regarded the agreement between the two methods of apportioning the total fuel consumption between the two engines, he held that it meant nothing. The second result did not confirm the first, but merely showed that at sea as on shore the exhaust gas temperature was proportional to the fuel consumption. It was noteworthy that during the full-power trial cylinders 2 and 5 of the port engine gave higher mean indicated pressures than the others—87.2 lb. and 89.2 lb., as compared with 85.2 lb., 85.9 lb., 84.5 lb. and 83.9 lb. for cylinders 1, 3, 4 and 6 respectively. The torsionmeter diagrams showed irregularities in the torque which could definitely be traced to cylinders 2 and 5. These irregularities might be described as being of the nature of misfires or late firing, followed during the next cycle by detonations, giving about 50 per cent. more torque than would have been generated had there been no detonation. There were no irregularities in the torque during the low-speed trial, and none during the high-speed trial, except in connection with cylinders 2 and 5.

Mr. Westgarth immediately challenged Mr. Moullin's deduction as to the great loss of power at sea between the engine and the propeller. It was unreasonable to suppose that the shaft bearings altered their behaviour to the extent indicated by Mr. Moullin's figures for the high-power trial and doubly unreasonable to suppose that thereafter their behaviour would be constant, as exemplified during the slow-speed trial. Mr. Moullin's figures, he held, did not suggest a defect in the bearings so much as a defect in the torsionmeter.

Mr. Narbeth, speaking of his experience when he was at the Admiralty, said that it was not always possible to compare the results of trials on different ships, as their accuracy was often open to doubt; but the trials carried out by the Committee were quite reliable, and had produced a fund of information which could be used in the future for comparison with the results of other trials. It was noteworthy, for instance, that the results of the trials on the test bed, on the same engines afloat and on the engines of the sister ship agreed very closely. One of the most noteworthy remarks of Mr. Narbeth was, however, his assertion that, in contradistinction to steam machinery, the fuel consumption of Diesel engines actually improved with age. He said that shipowners were beginning to wonder whether or not improvements in fuel consumption were set off by increases in the cost of maintenance, and said that he hoped shipowners would themselves provide some information on the subject. He said that heavy oil engines might well be advocated for powers up to 3000 horse-power. He favoured the use of steam, rather than electricity, for auxiliary services, as it was so handy for heating purposes. If, on the other hand, electrical engineers could evolve an economical system of heating with units working at a moderate temperature, an electrical system of auxiliaries would be preferable.

Commander Tostevin made some remarks on the apparent discrepancy in the report between the mean effective pressures recorded and suggested that inaccuracies might have been introduced by the stretch of the cord used to operate the indicator drum, rather than by the obliquity of the cord on its route from the rocking lever connected with the piston-rod to the indicator itself. Mr. Fielden also spoke.

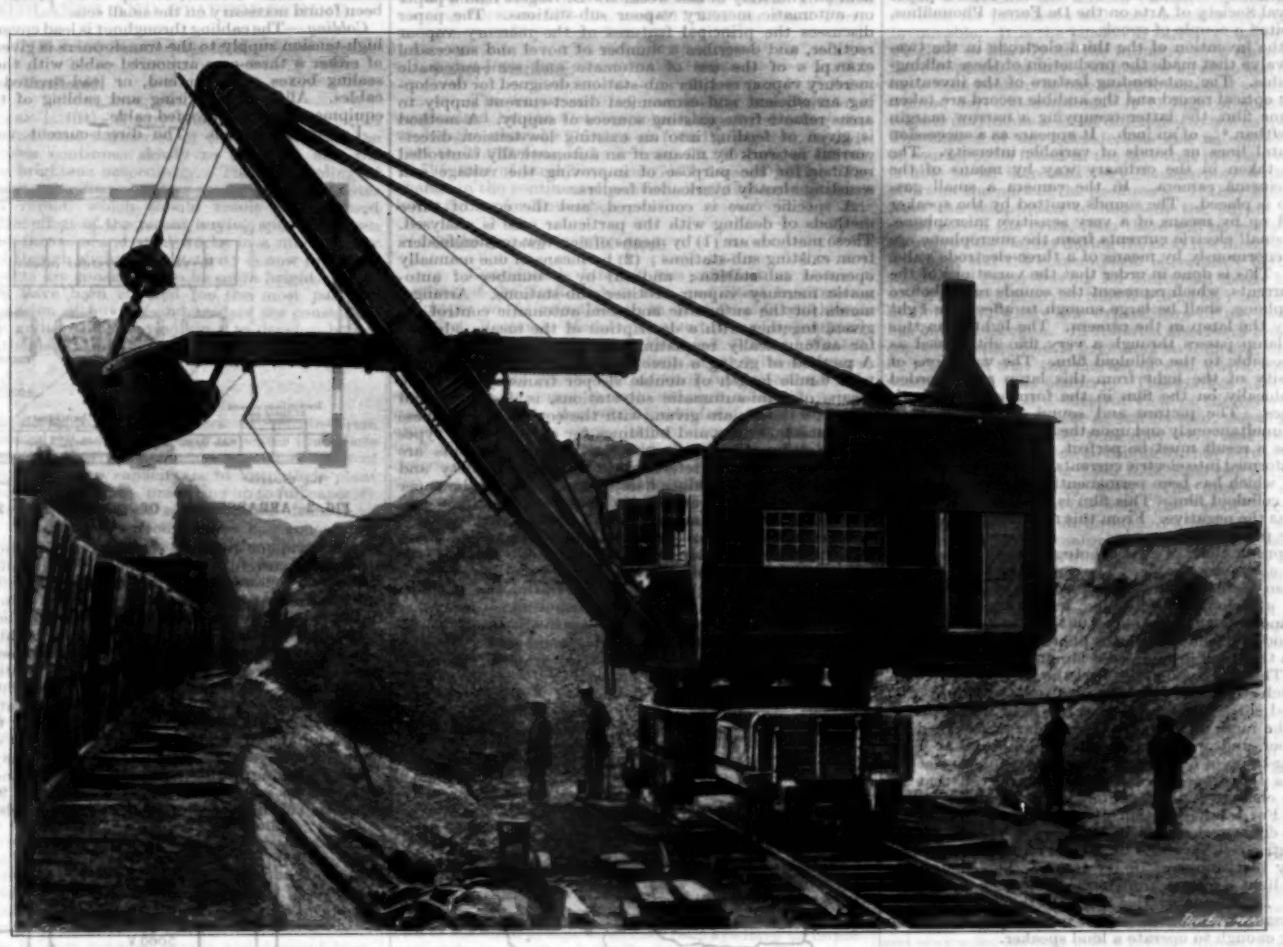
Mr. W. H. Patchell, before calling upon Sir George Goodwin to reply to the discussion, stated that but for the kindness and financial assistance of Furness, Withy and Co., Limited, and of Richardsons, Westgarth the tests could not have been carried through as they had been. Valuable assistance had also been received from Alfred Holt and Co., the Ellerman Line, the British India Steam Navigation Company, and others. He had pleasure in announcing that the Committee had now completed similar trials with the motor ships Pacific Trader and British Aviator, and was now testing a Cammellaird-Fullager and a Werkspoor engine.

Sir George Goodwin replied to the discussion, pointing out that the full value of the report would only be secured when the results of the remaining trials being carried out by the Committee were available.

THE total production of bituminous coal in the United States during the week ending October 18th was 10,255,000 net tons, and of anthracite 1,750,000 net tons. Exports of coal from Hampton Roads during the same week totalled 50,583 net tons. The corresponding figures for the week ending October 25th were:—Bituminous coal, 10,298,000 tons; anthracite, 1,927,000 tons; exports from Hampton Roads, 69,028 tons.

REVOLVING STEAM NAVVY

SIR WILLIAM ARROL AND CO., LIMITED, WESTMINSTER, ENGINEERS



A Large Steam Navvy.

THE accompanying illustration represents a standard Arrol-Whitaker No. 20 revolving steam navvy, which has recently been supplied to the Tunnel Portland Cement Company, of West Thurrock, by Sir William Arrol and Co., Limited, of Westminster. The weight of the machine in working order is given as being approximately 65 tons, and the capacity of the bucket is 2 cubic yards. It is said that the average working speed is from one to three operations per minute, but the makers only claim that its output is 600 cubic yards per eight-hour day, which is an average of 1¼ cubic yards per minute.

The following are the leading particulars :—

Effective pull on bucket	20 tons
Radius of cut at formation level	25ft.
Maximum dumping radius	34ft.
Maximum dumping height	25ft. 9in.
Maximum cutting height	35ft.
Depth of cut below ground level	4ft. 3in.
Centres of track rails	10ft. 6in.

The carriage is built up of rolled steel sections, and is fitted with large steel central castings. The centre boss is extended and is machined on the outside to form the centre pivot, round which the superstructure revolves, and the centre casting is bored and bushed with gun-metal to form a bearing for the vertical travelling shaft. The top of the carriage is arranged to support the roller path and the underside is fitted with bearing brackets for the travelling gear. The machine is carried on four cast steel double flanged wheels. Both axles are fitted with bevel wheels, and are driven by pinions mounted on the ends of a horizontal shaft, which, in turn, is driven by gears mounted on the vertical shaft that passes through the centre post, which connects the carriage to the revolving superstructure. The latter consists of a steel frame, which is extended at the rear to carry the "A" frame, boiler, water tank and coal bunker, brackets being provided at the side to carry a platform. The superstructure has machined faces on the top to which the machinery and bearing brackets are bolted, and there are brackets at the front for the jib foot. The jib is built up of steel sections and plates braced and riveted together, and at the top it is furnished with two cast steel sheaves for the hoisting rope.

The boiler, which is of the vertical multitubular type, is 5ft. 6in. in diameter by 11ft. 6in. high. The working pressure is 125 lb. per square inch. There are three engines —(1) the hoisting and travelling engine, with two cylinders, each 10in. bore by 12in. stroke, and fitted with reversing link motion having case-hardened working surfaces; (2) the slewing engine, with two cylinders, each 7½in. bore by 7in. stroke; and (3) the racking engine, with two cylinders, the same size as those of the slewing engine. The cylinders of the slewing engine are cast together, and so are the engine frame and guides, the ends being machined and drilled to receive the cylinders. The pistons, which have metallic rings, are connected to the piston-rod by cone and nut. The crossheads are of cast steel, while the connecting-rods and crank shaft are of forged steel. All the motions are controlled from the driver's platform by means of one foot and four hand levers. For hoisting, when the hand lever is advanced from the neutral position, steam is admitted to a small ram, which operates a clutch and couples the hoisting drum to the engine. On the lever being further advanced, steam is admitted to the engines and the bucket is raised. The bucket is lowered by means of a powerful foot brake. The travelling motion, which is also operated by the hoisting engine, is brought into play by means of a separate clutch, and a separate hand lever, connected to the link motion, is employed to reverse the engine. The slewing motion is operated by one lever connected to the piston valve, which is designed to allow the bucket to drift when swinging. The racking engine is operated by a piston valve connected to a single lever, the valve being so arranged that the bucket arm is held in any desired position when the valve is central.

The superstructure can revolve through a complete circle, so that the driver can dig or empty the bucket at any angle. It is mounted on four steel rollers turned conical on the tread and bearing on a cast steel roller path attached to the top of the carriage; the outside of the roller path has machine-cut teeth, into which gears a pinion mounted on the end of a vertical shaft driven by the slewing engine, through spur and bevel wheel reductions. The roller path is bolted by fitted bolts to a machined seating on the carriage.

The bucket arm is built up of heavy steel sections, and is fitted on the underside with cast steel racks, which are shrouded to the pitch line. It is lifted on three parts of best plough steel wire rope, one part winding on to a cast iron drum, which is turned and grooved, and of a sufficiently large diameter to take the full amount of rope at a single lap and which is driven by the engine through single reduction machine-cut steel gearing, a powerful clutch which is operated by a steam ram being interposed between the two. The bucket is fitted with hard steel teeth, and its back is a massive steel casting, which is fitted with lugs for the bottom door hinge pins. The door is fitted with a latch, and it closes automatically when the bucket is lowered to take a cut. The bucket arm is racked "in" or "out" by means of two pinions, that gear into the racks which are attached to its underside. The pinions are driven by the racking engines, which are mounted on the jib, through one reduction of spur gearing.

A house is fitted over the superstructure to protect the driver and gearing from the weather, and the ballast necessary for the stability of the machine consists of a cast iron slab bolted to the tail of the superstructure framing.

Lloyd's Register Scholarships.

THE Institute of Marine Engineers has just issued the following information regarding Lloyd's Register scholarships, student graduate examinations and essay competitions in 1925 :—

Lloyd's Register Scholarships.—Lloyd's Register scholarships are three in number, one being available each year for three years at £100 per year. They are bestowed by Lloyd's Register of Shipping. Application should be made by intending candidates not later than March 10th, in order that arrangements may be made for the examination on the dates announced below. The examination will be held simultaneously in the various centres to suit the residences of candidates. The regulations, with lists of subjects on which questions will be set, are as follows :—(I.) The scholarship is open for competition to candidates who are British subjects—that is to say, of British parentage in its Imperial sense—graduates, student graduates or associates of the Institute of Marine Engineers, apprentices or junior engineers (not necessarily connected with the Institute), the age limit being from eighteen to twenty-three at the date for entering the University. Preference will be given, in the event of nearly equal marks, to the candidate who acquits himself best at the subsequent oral examination before a special committee. The successful candidate, if not already associated, must join the Institute in the grade for which he is qualified. (II.) The scholarship is intended to assist marine engineering students, desirous of gaining higher attainments, better to qualify them for the duties of life in their chosen profession. An undertaking must be given by the successful candidate that he will continue his studies for the full period of the term, extending over three years, with a view to the B.Sc. degree. (III.) The examination papers will be set from and based upon the following subjects and the award will only be given in the event of a candidate showing sufficiently good qualifications.

May 6th: (*a*) Arithmetic, including the metric system, algebra to quadratics; (*b*) elements of statics, dynamics, thermodynamics, and hydrostatics; (*c*) geometry, based on Books I., II., III., and IV.; (*d*) general knowledge, English composition. May 7th: (*e*) theoretical mechanics, principles and problems; (*f*) foreign language—choice given to the candidate, who is required to notify this on his application—elementary construction and translation; (*g*) trigonometry, including logarithms; (*h*) practical engineering and workshop practice.

As the object of the scholarship is to provide means for young engineers to add to their proficiency as marine engineers, only those are eligible who have served at least two years in a commercial engineering workshop, and until the time of application have been employed at engineering, either ashore, afloat, or at college, with the intention of entering upon the business of marine engineering, but not necessarily to remain a sea-going engineer. Subject to the approval of the Council, the successful candidate may choose the university or college most convenient to himself, but he must take all the classes in the recognised curriculum for engineering students at the university or college chosen.

Student Graduates.—Applications to sit at the student graduates' examinations will be received till March 30th. The dates and subjects for the examination are :—April 7th, theoretical mechanics, heat and heat engines; April 8th, machine construction and drawing, applied mechanics; April 9th, mathematics, including geometry, English language, including composition; April 10th, electrical engineering. Further particulars may be obtained on application to Mr. James Adamson, hon. secretary, the Institute of Marine Engineers, 85-88, The Minories, Tower-hill, London, E. 1.

Talking Motion Pictures.

On Wednesday evening Mr. C. F. Elwell read a paper at the Royal Society of Arts on the De Forest Phonofilms, and exhibited a couple of spools.

It was the invention of the third electrode in the two-electrode valve that made the production of these talking-films possible. The outstanding feature of the invention is that the optical record and the audible record are taken on the same film, the latter occupying a narrow margin of no more than $^{3}/_{32}$ of an inch. It appears as a succession of horizontal lines or bands of variable intensity. The picture is taken in the ordinary way by means of the ordinary cinema camera. In the camera a small gas-filled lamp is placed. The sounds emitted by the speaker are picked up by means of a very sensitive microphone. The very small electric currents from the microphone are amplified enormously by means of a three-electrode valve amplifier. This is done in order that the variations of the electric currents, which represent the sounds made before the microphone, shall be large enough to affect the light emitted by the lamp in the camera. The light from this gas-filled lamp passes through a very fine slit placed as close as possible to the celluloid film. The variations of the intensity of the light from this lamp are recorded photographically on the film in the form of these horizontal lines. The picture and sound have thus been recorded simultaneously and upon the same film. Synchronisation as a result must be perfect. Sound waves have been transformed into electric currents and electric currents into light, which has been permanently recorded upon the sensitised celluloid film. This film is then developed and is known as the negative. From this negative any number of positive prints can be made.

The reproduction of the photographically recorded sounds is also very simple. The roll of positive film is placed in an ordinary cinema projector, to which has been fitted an attachment containing a small incandescent lamp, a fine slit which is only .0015in. wide and $^{2}/_{10}$in. long, a guide for the film and a photo-electric cell. The light from the small incandescent lamp shines through the fine slit. The film is guided so that the portion of the film upon which the sound is recorded passes before this illuminated slit. The intensity of the light which passes through the more or less translucent film is governed by the number and width of the horizontal lines. This fluctuating beam of light then falls upon the photo-electric cell. It is the property of a photo-electric cell that its resistance changes with the intensity of the light falling upon it. For talking motion picture work it is essential that these changes should be instantaneous. The Thalofide photo-electric cell, invented by Mr. T. W. Case, is in effect practically instantaneous in its action. The fluctuating beam of light is thus transformed into small electric currents. By means of the three-electrode valve these small currents are again increased in strength, until they are strong enough to operate a loud speaker.

As might be anticipated from this brief description, the synchronisation of picture and sound was perfect in the films exhibited by Mr. Elwell. The only defect that remains to be overcome resides in the loud speaker, which, as every one knows, does not record all sounds with equal accuracy. Two films represented speakers delivering addresses. In them the illusion was spoilt by the volume of sound. No man could speak in such thundering tones. It is clear that if the instrument is to be used for the drama the volume of sound must be reduced, without muffling, until it is commensurate with that of a human voice. In singing the illusion was more perfect by many degrees, and in a dance performed to music, but without voices, the illusion was very nearly perfect.

It can be said that Dr Lee de Forest's invention has brought the speaking film to a far higher state than before, and that it only remains to remove the notorious defects from the loud speaker to reach perfection.

TRIALS OF SUGAR BEET ROOT LIFTERS.

The Royal Agricultural Society of England is proposing to hold trials of sugar beet root lifters next year. These trials will take place in or about the month of October, 1925, in the neighbourhood of Kelham, near Newark. There will be two classes. Class I., for machines which top and lift the roots and separate them from the leaves and crowns; and Class II., for machines which loosen the roots, leaving them subsequently to be lifted and topped by hand. Entries will be closed on or about May 30th, 1925.

The points to which the judges' special attention will be directed are:—(1) Price; (2) simplicity in design and working; (3) draught; (4) ease of handling; (5) ease in turning; (6) efficiency in lifting or loosening roots; (7) freedom from damaging roots; and (8) effective separation of leaves from root. The Society's implement regulations will apply to these trials generally.

Further particulars will be available early in 1925, when they will be obtainable from the secretary, Mr. T. B. Turner, 16, Bedford-square, London, W.C. 1.

The recent accident at Lytham has revealed the fact that the maintenance of what was the Preston and Wyre Joint Line is now under the northern division of the former London and North-Western Railway. This fact is of interest in that the Preston and Wyre was always more Lancashire and Yorkshire than North-Western. The former company at one time—in 1846—had it wholly in its possession, and when in 1849 it became jointly owned, the Lancashire and Yorkshire had two-thirds interest. On the other hand, the London and North-Western had two-thirds interest in the North Union, which was the line from Euxton Junction to and including Preston Station. The North Union originally extended from Preston to Warrington and to Bolton, but later it ended at Euxton, and the North-Western took the section thence to Warrington and the Lancashire and Yorkshire the line to Bolton.

Mercury Vapour Sub-Stations.

At a meeting of the Institution of Electrical Engineers held on Thursday of last week, Mr G. Rogers read a paper on automatic mercury vapour sub-stations. The paper discusses the principal features of the mercury vapour rectifier, and describes a number of novel and successful examples of the use of automatic and semi-automatic mercury vapour rectifier sub-stations designed for developing an efficient and economical direct-current supply to areas remote from existing sources of supply. A method is given of feeding into an existing low-tension direct-current network by means of an automatically controlled rectifier for the purpose of improving the voltage and assisting already overloaded feeders.

A specific case is considered, and the cost of three methods of dealing with the particular case is analysed. These methods are (1) by means of new low-tension feeders from existing sub-stations; (2) by means of one manually operated sub-station; and (3) by a number of automatic mercury vapour rectifier sub-stations. Arrangements for the automatic and semi-automatic control are given, together with a description of the means adopted for automatically regulating the direct-current voltage. A method of giving a direct-current supply at 550 volts to a 6-mile length of double sleeper tramway track, by means of semi-automatic sub-stations, is described, and complete details are given, with the cost of one of these sub-stations. Sites and buildings for each of these types of sub-stations are discussed, and general lay-outs are given, with special reference to simplicity, safety and cheapness. We reproduce here the main part of the paper dealing with small automatic three-wire rectifier sub-stations for outlying areas, housing schemes, &c.

Fig. 1 shows an outline map of the Birmingham area, indicating the position of the generating stations, the existing manually operated rotary converter sub-stations, and the position of the rectifier sub-stations in the outlying areas, each having its own distributing network.

These outlying areas are comparatively thinly populated. A 5000-volt three-phase ring main passes through this area, looping into the various sub-stations. Connections have also been made to other existing ring mains in the area.

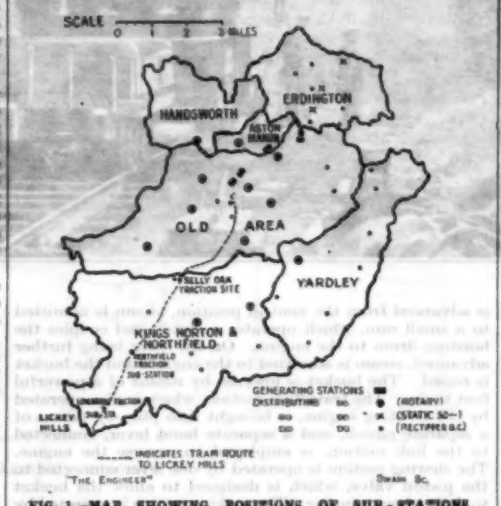


FIG. 1—MAP SHOWING POSITIONS OF SUB-STATIONS

It was decided to commence operations with a three-wire unit, having a capacity of 46 kilowatts, the transformer supplying the two 23 kilowatt rectifiers being designed for an ultimate load of 92 kilowatts. Two 100-ampère 230-volt glass bulbs were connected in series across the outers of the three-wire network, the neutral or third wire being connected between them; and later, by the addition of two further bulbs of the same capacity in parallel, the unit was brought up to its full capacity of 92 kilowatts.

Certain of these sub-stations have already been brought up to the 92-kilowatt capacity, owing to the rapid growth of the demand in these areas.

Provision is made in each case for an extension to the buildings when necessary. It is proposed to install in the extension a unit having a capacity of 138 kilowatts, making the total capacity of each of the small sub-stations 230 kilowatts. This extra capacity has now been added in several cases, and is likely to be enough for any particular area. When the full capacity of the station has been reached, it is intended to develop areas in the district by means of further similar sub-stations.

Lay-out of Plant.—Fig. 2 shows the general lay-out of the plant in one of these sub-stations. The dimensions—*i.e.*, 30ft. by 20ft.—of the sub-station have been kept as small as possible, due regard being given to ample passage ways and easy removal of the plant.

The rectifier cubicles are totally enclosed, and no live parts are exposed. The high-tension and low-tension switch gear is also totally enclosed, and every care is given to provide safety and simplicity in operation.

Fig. 3 shows the general electrical connections in a complete sub-station, but does not include the internal arrangements of the rectifier. It will be seen that the high-tension feeder is looped into the sub-station, the oil switches being non-automatic in operation.

The transformers, on the other hand, are protected by overload coils in each phase. Leakage protection is also provided by means of a current transformer in the "earth" connection of the transformer tank. A leakage of 2 to 3 ampères to earth is sufficient to cause the main oil switch to open. The current passing through the current transformer operates a special relay which, in turn, closes the trip circuit energised from the 230-volt circuit.

The rectifier itself is equipped with automatic gear, which, in the event of a failure of the alternating-current supply, will strike the ignition arc in the bulbs when the current is restored, and resume the supply to the external direct-current circuit. No automatic switchgear is provided on the direct-current side. Each connection to the distributing network is protected by means of fuses. It may be necessary later to equip each of the rectifiers with a reclose overload circuit breaker, but up to the present it has not been found necessary on the small sets.

Cabling.—The cabling throughout is lead covered, and the high-tension supply to the transformers is given by means of either a three-core armoured cable with the necessary sealing boxes at either end, or lead-covered single-core cables. All internal wiring and cabling of the rectifier equipment is of fire-proofed cable.

Voltage Regulation.—The direct-current voltage of a mercury vapour rectifier is directly proportional to the alternating-current voltage supplied to the anodes of the bulb. It follows, therefore, that, in addition to the voltage drop of approximately 5 per cent. from no load to full load, there may be variations due to the variations in the alternating-current pressure. If, as in this particular case, the ring main feeder is fed from the same feeders that supply large power consumers, such variations may be fairly large. To meet this, an arrangement has been developed to operate the voltage regulator automatically. The rectifiers are provided with a regulating transformer with a number of tappings, and by means of sliding contacts the voltage of the supply to the anodes may be varied.

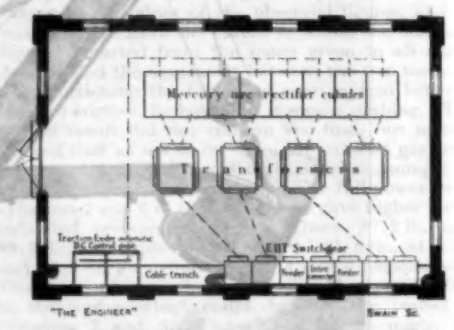


FIG. 2—ARRANGEMENT OF 46-KW. SUB-STATION

The following is the detailed cost of a standard three-wire rectifier sub-station containing plant of 92 kilowatts capacity, two high-tension feeder switch panels, one transformer high-tension switch panel, and low-tension iron-clad switchgear for controlling four outgoing three-wire low-tension distributors.

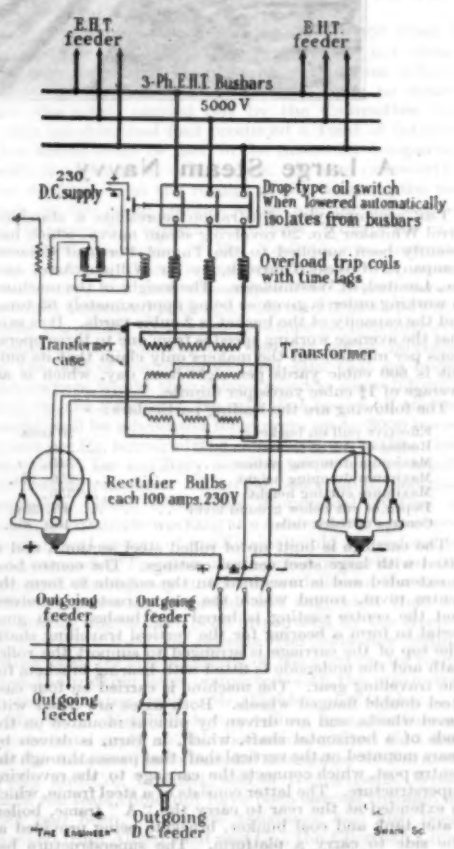


FIG. 3—SUB-STATION CONNECTIONS

The costs include all the interconnector cables between the high-tension oil switch and the transformer, between the transformer and the rectifier, and from the low-tension side of the rectifier switchgear to the distributing gear.

The costs also include all labour charges and sundry materials.

	£
Cost of 92-kilowatt 3-wire rectifier plant	1478
E.H.T. switchgear, two-feeder panels, and one transformer panel	130
Low-tension direct-current switchgear	32.65
Automatic regulating gear and switches and resistance for B.O.T. earthing panel	85
Cabling	45
Labour costs for erection	40

The cost of the sub-station building for housing this plant, including cable trench, chequer plating, drainage, fencing, &c., is £320.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Situation Unaltered.

THERE is little if any change in the situation in the iron and steel industries of the Midlands on the week. Business continues slowly to improve, and the market tone brightens accordingly. The new feeling of confidence now generally prevailing should produce greater stability all round, which should result in increased business. The effect of the recent buying spurt has been to place blast-furnaces and steel works in a much better position, and though slightly less activity is now reported, future prospects are considered to be quite bright. Near requirements have been covered for the most part by the late expansion of buying, and traders are considered merely to be giving the situation time to develop before committing themselves further.

Steel Prices.

The decision of steelmakers to refrain from price increases at the moment clearly indicates that there is a lot of unemployed plant, and the main concern of owners of mills of large capacity is to keep their plant running through the 24 hours, producing up to full capacity on the triple eight-hour shift system. This decision of steelmakers to maintain current prices has encouraged a waiting policy on the part of buyers, although orders are still placed with much more confidence, the general view being that any further market fall is not to be feared. Angles and joists continue on the £9 5s. basis, with a possibility of buying at £9 for an attractive line. Small bars, in spite of the efforts to stabilise prices at a higher level, can still be bought at £9 5s. Mild steel strip rolled from English billets is firmer at £11 10s., and ordinary tube strip fetches £10 10s. Some makers are quoting £7 15s. for billets, an increase of 5s. per ton, but merchants and others have no doubt of their ability to buy at the recent standard of £7 10s. A matter of great importance to the trade is the relaxation in foreign competition, many Belgian and French makers no longer offering steel here, while the few quotations in the market name advances of something like 10s. per ton, and, as a rule, include a time limit. Thus Belgian billets, which lately could be bought at £6 5s., now cost £6 15s. Finished steel is only about 5s. dearer, and is quoted £6 f.o.b. Antwerp. But the withdrawal of numerous manufacturers from the market prevents those quotations being taken at their face value. This appreciation of continental prices has steadied the market for steel generally. It has not done very much to redress the balance between supply and demand however. With a moderate amount of buying Midland steel works should be secure of activity until the end of the year.

Pig Iron Business.

Midland producers of pig iron are much better situated for orders. They have disposed of large quantities of stocks, and are much less anxious to get business. They are not prepared to give very much latitude to forward buying. Pig iron has been sold to a substantial amount as things go now over the next three months. Smelters must needs go warily, however, as coke supplies are not covered beyond the end of the year. This is an important factor in the forward position. There is much satisfaction among smelters that so far furnace coke prices have not increased, and they are accordingly able to retain whatever advantage they secure from improved prices. Some sellers on 'Change in Birmingham to-day —Thursday— ndeavoured to get higher prices for foundry material, but they did not meet with much success. Prices are very firm however. Northamptonshire No. 3 foundry commands £3 17s. 6d., and Derbyshire £4 2s. 6d. Buyers of North Staffordshire iron, where the make is severely restricted, have to pay £4 7s. 6d. There is still only a slack inquiry for forge qualities. Northamptonshire makes are quoted £3 10s. to £3 12s., and Derbyshire £3 17s. 6d. per ton at furnaces. Basic pig cannot be bought for January delivery at the prices which smelters are prepared to take for prompt despatch. Though furnaces have been restarted in other areas, with the prospect of others to follow, increased output in this district is not regarded as likely for some little time.

Staffordshire Finished Iron.

The Staffordshire finished iron trade remains much the same as a week ago. A few additional contracts have been secured and better buying than of late is generally reported. Negotiations for supplies are on broader lines, but manufacturers do not find specifications coming in on a corresponding scale. Encouraging sales of marked bars have, however, been made, and producers find no difficulty in maintaining the £15 standard. The improvement in Crown bars is not so well defined, but there is some resuscitation. Makers are once more arranging forward contracts, a development which has not taken place for months. A lot of work will be wanted in the Black Country to secure all round activity. Values are firm at £12 15s. What movement there is in nut and bolt bars has its origin mainly in special departments of the district trade. Prices are maintained at £11 15s. per ton. Makers have still to meet competition from Belgium No. 3 iron at £7 12s. 6d. delivered.

Scrap.

Steel scrap continues at very low prices, but there is an inclination to buy speculatively if merchants would accept the present prices for forward delivery. This, however, they decline to do, anticipating more remunerative figures towards the end of the year. Wrought iron scrap is selling rather more freely at about £4 15s. per ton delivered.

Sheet Values.

Galvanised sheet prices continue to gain strength as the result of improved buying, and corrugated sheets of 24-gauge have this week changed hands at prices ranging between £17 10s. and £17 15s. per ton. Ferro-manganese is £1 per ton dearer at £14 10s.

Import Statistics.

The importance of continental competition is emphasised by the October import figures showing that we bought abroad 8775 tons of foundry pig iron, in addition to 22,223 tons of basic iron, 59,205 tons of billets, 49,794 tons of steel bars, and 7177 tons of joists. The change in the continental position should bring very much lower figures for November.

Grain Growth in Mild Steel.

Considerable interest was manifest at a recent meeting of the Staffordshire Iron and Steel Institute in the paper on "Grain Growth in Mild Steel," which won the first Research Medal presented by the Institute. It was read by the author, Mr. Francis S. Dodd, of Walsall, who, after dealing with the findings of other investigators, summarised the results of his own investigations. He stated that abnormal growth did not occur in Armco iron, whatever the degree or kind of deformation, when annealed at 650 deg. Cent. All mild steels containing up to 0.25 per cent. carbon would, if sufficiently plastically deformed, grow large grains upon annealing between 600 and 700 deg. Cent. If the temperature of annealing was too low, no exaggerated grain growth would take place, however great the deformation. The effect of carbon was to make a higher degree of stress necessary to produce growth. Finally, the grains in a work-hardened piece of steel which had been annealed at too low a temperature to produce growth would, upon annealing at the proper temperature, grow as if it had received no previous annealing. Failures due to grain growth occasionally occurred in boiler plates, and the results were sometimes very disastrous. The processes which boiler-plates underwent were very conducive to grain growth. Boiler-plates and other mild steel plates were liable to de-carbonisation.

A Black Country Innovation.

The execution of an order for between 10,000 and 12,000 tons of railway chairs by a Black Country firm for the Great Western Railway Company marks the opening of a new field of activity in that district which it is hoped may receive adequate encouragement for its full exploitation. Hitherto railway chairs have been made chiefly on the North-East Coast, but industrialists hereabouts hope that the placing of this order for chairs by the Great Western Company means that South Staffordshire may look for further similar business in the future. Two of the main groups of British railways have an important stake in the South Staffordshire trade. They carry a vast amount of traffic to and from the district. The railways reciprocate, of course, by placing a good many orders in the district directly and indirectly. It is hoped that railway chairs will be included in the contracts which in future make their way to this district.

Rolling Stock.

Midland rolling stock concerns, taken on the whole, are fairly well employed. In some cases railway wagon makers are assured of steady employment until March next, but, on the other hand, there are firms which can only see a month or two forward. On the carriage side there is more activity than for a long time past, and contracts are going through both for home and export. There are many inquiries out for rolling stock, and makers realise that to succeed in getting contracts they will have to cut the price very fine, as everybody in the industry, whether at home or abroad, is anxious to make sure of steady employment in the new year.

Coventry Engineering.

The Coventry engineering industry continues to show improvement, and the healthy tone noticeable in trade circles during the past few weeks is maintained. The important motor engineering works manifest increasing activity, the machinery in numerous instances being kept running day and night. The demand is such that some firms are already behind their order lists, and cars are being turned out for immediate delivery as quickly as capacity will allow. Export business is now showing signs of improvement, and with the prospect of a period of stability, there is reason to hope that some of the lost ground will be recovered.

Unemployment.

The latest returns of unemployment in the Midlands show a further welcome decrease in the total number. On November 17th the number of persons unemployed was 142,740, as compared with 143,871 for the previous week, a drop of 1131. In Birmingham the decrease was 551, and in Coventry 232. The aggregate was made up of:—Men, 101,585; boys, 1824; women, 36,528; girls, 2803. In the Birmingham area the number of workless now stands at 33,281; Bilston, 3257; Coventry, 2509; Cradley Heath, 4512; Dudley, 4304; Oldbury, 1854; Smethwick, 4838; Stourbridge and Brierley Hill, 3971; Tipton, 2362; Walsall, 5110; West Bromwich, 3581; Wolverhampton, 5830; Worcester, 1794; and Redditch, 1334.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Metals.

The markets for the non-ferrous metals are certainly in a better position, and here the opinion is growing that while lead, and perhaps spelter, are high enough, there is considerable room for higher copper prices. Merchants are beginning to think that buying of copper is now a good proposition, and it may be that during the next few weeks a good deal of buying of this kind will take place. It is clear that if merchants and consumers of copper begin to assume the burden of carrying the stocks, the outlook for producers will soon become very much more favourable. It is the burden of carrying copper which has weighed so heavily on the industry ever since merchants have kept out of any speculative buying, and consumers have been content to buy small lots as and when they were wanted for consumption. A change of feeling in this respect may make a lot of difference to the copper market. The chance of any considerable rise in copper prices is, of course, to be found in the fact that productive capacity is able to be increased very considerably without much effort on the part of the producers. If they should refrain from the temptation to augment the output with each small rise in the price, then there will be every chance of an improving market during the next few months. Copper is cheap, and the consumption is certainly better than it was. The larger buying for European needs has begun, and it is not improbable that it will go on; more especially in Germany, where the expenditure of the last big loan has only just begun. In America also there are signs that copper consumption is beginning to improve, and it must be admitted that the market is well worth watching by consumers in this country. The market here for tin is fairly steady, and a cheerful view of the future prices is generally taken. So far as can be seen, the prospects for higher prices are better than they were, and those optimists here who have been so confident that by the end of the year tin will be nearer £300 than £250 per ton, are more complaisant than they were. The idea is, of course, that in the course of a few weeks the "pool" stocks in the East will have been all liquidated; and then, if the rate of consumption is maintained there may easily be a scarcity. Any rapid increase in the monthly output of tin seems unlikely at present, even if it be possible in the future. Lead remains a very good market, although prices have possibly reached a dangerous level. Spelter, however, although very much better than it was, is not yet dangerously high.

Pig Iron.

The markets here for foundry pig iron remain steady, but rather quiet. Of course, the buying movement of the beginning of the month is now over, and the question at the moment is whether any of our Lancashire ironfoundries have secured any increase of business to correspond. There is a hopeful feeling here in the textile engineering trade, based upon the belief that the cotton mills are now making money; and, of course, it is well known that the renewal of machinery in many of the mills is long overdue, and it is believed with some confidence that so soon as spare capital is available, it will be spent in textile machinery. This movement may come in time to justify the buying of pig iron which has taken place, and may even perhaps give a further fillip to the market; but the general idea here is that there will be no further change in pig iron prices this year. Sellers of Derbyshire No. 3 iron continue to quote 90s. per ton for delivery in Manchester, but there is some Northamptonshire iron to be had at a little less, and that in spite of the heavy carriage on this make of pig. Only a small quantity of Lincolnshire iron is now on the market, and the price is the same as for Derbyshire. Scotch iron is steady at 107s. 6d. per ton, but there is not much inquiry for it, although there would be a better demand if the textile engineers got busy again.

Finished Material.

The demand here for manufactured iron and steel remains very much as it was. There is but little indication of improvement so far as fresh business is concerned, but at the same time a rather more cheerful feeling is about. The main difficulty is, of course, that there are too many sellers and too few buyers, and in such circumstances prices cannot rise, even to the very moderate extent which has been seen in pig iron. There are still sellers of joists and angles at £9 per ton, although some people try to get £9 2s. 6d. The price cannot be remunerative to steel makers, nor, in fact, are any of the other prices. Plates are quoted from £9 15s. to £10, and bars from £9 17s. 6d. up to £10 10s.; but good makes of round heavy bars can now be bought at £10 5s. The only favourable feature in this section of the market is that the continental position is firm, and the hope is expressed that the gap between foreign and British prices will diminish.

Scrap.

The markets here for cast and wrought scrap are practically unchanged. The demand in each case is small and the prices rather weak. Ironfounders have not yet begun to buy the scrap which they will require if they are going to use up at all quickly the pig iron which has been bought since the beginning of November. Steel scrap, on the other hand, is firmer, and better prices are being paid in Sheffield, which justify an advance of 5s. in the price paid by dealers in Lancashire. It looks now as if the purchases of Lancashire scrap which have recently been made at 60s. per ton on trucks would pay very well.

A New Apprenticeship Scheme for the Building Trades.

At a conference of local authorities of Lancashire and Cheshire held in Manchester on Monday, under the auspices of the National Housing and Town Planning Council, approval was given to a scheme whereby the labour scarcity in the building trades may be partially solved. The scheme, which has been devised by Councillor Miles Mitchell, of Manchester, has been approved by representatives of both employers and employed, as well as by the Manchester Housing Committee. It does not aim at "dilution" in the usual acceptance of the term in labour circles, but rather at convincing the parents of boys that the building trade offers good prospects of regular and well-paid employment, and at inducing boys to enter it. With these objects it is proposed to form a committee composed of eight employers, eight operatives and four members of the Housing Committee, who will consult from time to time with the Manchester and Salford

and District Building Trades' Apprenticeship Joint Council as to the number of apprentices to be tra ned in the several branches of the industry. They will keep a panel of employers who are willing to take and train apprentices in the practical work of the industry, and advise as to conditions of apprenticeship. The scheme will be available to youths between the school-leaving age and twenty years, and these must undertake to be indentured and to attend technical classes. There will be a probationary period for lads under sixteen years of age. It is stated that the scheme will not in any way clash with the national scheme which the Whitley Council is considering. The scheme received unanimous acceptance by the meeting, and is recommended to the favourable consideration of other local authorities. It is certainly a step in the right direction.

Pass-out Turbines.

There was an excellent attendance of members of the North-Western Branch of the Institution of Mechanical Engineers at the meeting held in Manchester on Thursday, the 20th inst., to hear Messrs. Burge and Chittenden's paper on "Pass-out Turbines." The paper opens with a dissertation on the theoretical considerations of the subject, showing the economies that can be effected by "bleeding" turbines for process work and for heating purposes, as compared with separate installations for power and heat. The authors then go on to describe how the pass-out process is brought about by the builders of several of the best-known kinds of steam turbines. Incidentally, it appeared that one of the difficulties in the use of "pass-out" turbines was in connection with plants in which the demand for steam for heating varied considerably. It is not too generally known that Manchester has an installation of that kind at the Bloom-street electric power station, belonging to the Corporation, from which bleeder steam from turbines is supplied to heat a large block of buildings in close proximity belonging to the Calico Printers' Association, and, judging from the remarks of one of the speakers in the discussion which followed the reading of the paper, one of the difficulties in connection with this installation is due to the extreme variations in the demand for heat, it being necessary at certain times to obtain live steam from other sources of supply than the turbines. I gathered from what was said that there is no likelihood of any extension of this system of heating buildings in the neighbourhood on account of the very high cost of installing the mains, and the subterranean troubles which may be encountered in laying the mains, quite apart from the damage likely to be caused to the electric supply mains in the neighbourhood, owing to the heat transmitted from the steam mains.

BARROW-IN-FURNESS.

Hematites.

The improvement already noted in the general condition of the hematite pig iron trade of North Lancashire and Cumberland is well maintained, and further expansion is looked for in the immediate future. There is no big rush of business, but the trade being done is such that iron held in store is being cleared, and generally the demand is in excess of the production. There are in all thirteen furnaces in blast. It is expected a furnace will be put into operation at Cleator Moor shortly. The local demand for iron is fuller, so far as Barrow steel makers are concerned, but the Workington steel makers' wants are only moderate. In some parts of the district iron is being smelted for delivery to the United States. Prices are firmer.

Iron Ore.

To meet an increased demand for iron ore, more metal is being raised in both North Lancashire and Cumberland. There is only a moderate demand on the part of outside users, but a fair tonnage of high-grade ore is leaving the district. A cargo of North African ore has been discharged at Barrow.

Steel.

In the steel trade there is again activity at Barrow. The works had been closed down since the end of August, but with the booking of an order for steel rails for New Zealand, rolling restarted on Monday, and will go on for some time. At Workington the rail mill is working this week. The demand for rails, however, is far from satisfactory. For hoops there is a good steady demand on overseas account, so that the plant at Barrow is well employed, and the steel foundries are also busy. Steel prices remain unchanged all round.

Fuel.

For fuel there is rather better business to report, both for coal and coke, most of the latter coming from the East Coast, alghough fair tonnages of Cumberland coke are now used.

Shipbuilding and Engineering.

There are no new features to report in these trades. Progress is being made on the stocks with a British cruiser, an Orient liner, and a Furness-Withy steamer. The engineering shops are busy on marine, gun and general work.

SHEFFIELD.

(From our own Correspondent.)

A Brighter Outlook.

THE condition of the raw material and semi-manufactured steel trades shows no improvement, as there is little forward buying, and the new orders coming in are not more than sufficient to replace the old orders worked off. There is, however, a marked increase in the number of inquiries, and the outlook is considered brighter. The latter part of the year is usually a time of small buying, consumers reducing their purchases and keeping stocks as low as possible. At the same time, they are busy considering offers for delivery in the new year. In view of these facts, and the number of inquiries that are about, the situation may really be a good deal better than the actual amount of trade on hand would suggest. A hopeful sign is the fact that continental competition has weakened, and prices of foreign material are higher than they have been for a long time. It is hoped the demand will reach a point sufficient to warrant an increase in prices, so as to place the trade on a remunerative basis. The making of pig iron and billets in the past has entailed considerable losses. Recent savings in costs have improved the situation, and in some cases have turned the scale, but very little profit is being made yet.

Railway Supplies.

In the railway steel departments activity keeps up very well. There are good orders on hand for axles, tires, and springs, from the home companies, and an improvement in the receipt of work from overseas is reported. A large share of Indian and South American work has for some time been going to Belgium and Germany, but recently the United Kingdom has booked orders, representing a very large amount of money, for locomotives, wagons, cranes, locomotive tubes and engineering equipment. It is thought that continental competition will not be so keen in the future. Local firms have lately been making special efforts to counter it by quoting very keen prices, which will leave little profit unless the plants can be kept fully at work. The builders of private wagons are placing very few orders for material with Sheffield just at present.

The Engineering Side.

Variable conditions prevail in the departments producing heavy steel forgings and castings. At some works a good volume of orders is on hand, but there are many which are not so well placed, and the total amount of buying from the engineering industry is much below the normal. There is more work at the rolling mills, but most of the orders are small, and their execution rather costly. A capital amount of work continues to come forward for manufactured steels, special steels, and magnets for the motor trade. A large number of firms are sharing in this business. The tool steel branch makes a very slow and partial recovery. Trade in this department with the Continent, and with America, is still on the small scale, though some of the European countries are increasing their purchases. A rather better demand for engineers' small tools exists, and various hand tools are selling fairly well both at home and overseas, though there appears to be some tapering off in the trade as the year draws to a close. Agricultural tools are in poor request, and very little material for implement making is being bought from Sheffield. In the file trade a considerable recovery has taken place from the state of depression which prevailed a year and a half or two years ago. Output is not yet up to the normal, but is estimated at about 90 per cent. of the pre-war average. Competition, however, is so keen that the trade yields little return on the capital invested in it.

Doncaster Electricity.

The increasing demand for electricity at Doncaster has led to extensions of the municipal undertaking, which have been in progress for upwards of four years, and were formally opened last week. A new rotary converter has been installed, with a capacity of approximately 1750 horse-power. It feeds a double network with energy at a pressure of 440 volts for power, and 220 volts for lighting purposes. It has been supplied by the General Electric Company. There have also been many extensions of the steam raising plant, including two water-tube boilers, with superheaters, mechanical stokers, fuel economisers, soot blowing equipment, induced draught fans and self-supporting chimneys, together with complete ash disposal plant. This part of the new installation has been supplied by Babcock and Wilcox. The total cost of the extensions is about £113,000. At the opening ceremony, Alderman Dowson, chairman of the Electricity Committee, quoted figures showing the great economy which had been effected in the coal used for power purposes. In 1920, he said, the coal used at the works amounted to 10,493 tons, whereas in 1924, to do 50 per cent. more work, the consumption was only 7059 tons. The demand for current showed a great increase, reaching nearly 7,000,000 units in 1924. They hoped in the future to introduce a uniform rate of charges, no matter for what purpose current was used.

Rotherham Technical College.

The Rotherham authorities are considering the question of providing a Technical College and School of Art for the town, at an estimated cost of £56,000, towards which a grant from the Miners' Welfare Fund is thought probable. The Education Committee has had a report on the subject from its secretary, and has approved it for submission to the Borough Council and the Board of Education. It recommends that competitive plans be obtained, premiums valued £200, £100, and £50 to be offered.

Cutlery and Plate.

There is not much change to report in the cutlery trade, which is still busy—or, at any rate, a good deal busier than for some time past—on orders for the Christmas sales. The demand for stainless steel table knives is on a very large scale, and more is being done in pen and pocket knives, while the razor branch, although badly hit by the popularity of the "safety," shows some improvement. The electro-plate trade is still enjoying much activity in its spoon and fork departments, and there is a very large demand for cheap cased goods. In high-class silver and plate, however, things are still quiet. Shopkeepers' orders have fallen off, and the bulk of the work on hand is for hotel and ship equipment. The export trade in plate is comparatively small, although it has shown more life lately. The best markets are Canada and Australia, but there is little briskness about the trade with South America, South Africa, and Scandinavia.

A Busy Firm.

The well-known firm of Mappin and Webb had an official opening of its new Royal Works last week, and Mr. A. E. Bassett, a director, was able to give a very good account of the state of trade. For the past twelve months, he said, they had been working full time, and now they had a full order book covering work for many months ahead. They had on hand, or were completing, the entire equipment of Prince's plate and table cutlery for five new first-class ocean-going passenger steamers, and for a large number of foreign as well as British railway dining cars, and held many equally large orders for hotels and restaurants, both at home and abroad. There appeared to be a definite improvement in trade, a somewhat healthier outlook in regard to European difficulties, and they had a new Government at home from which they hoped to derive immediate benefit if only from a sense of security, and the hope of industrial peace.

A Leeds Reservoir Embankment.

There has been a movement on the embankment under construction at the Leighton Reservoir of the Leeds Corporation, and remedial measures have been adopted, which it is hoped to have completed in about twelve months. Alderman Oldroyd, chairman of the Leeds Waterworks Committee, in a statement on the work to be done, says it consists in supporting with heavy, stony material, the lower parts of the embankment, where consolidation may not be as yet complete, so restraining any further movement of material in a horizontal direction. Stone to a depth of about 5ft. will be added to the toe of the embankment. Additional stony material will then be continued from the toe upwards, until the filling attains a depth of some 15ft. immediately above the place where the movement showed. The top slope of the embankment will then be continued in the same material at a gradient flat enough to prevent any movement in the future. Mr. Oldroyd adds the reassuring statement that the stability of the reservoir embankment as a whole has not been affected by the movement.

NORTH OF ENGLAND.

(From our own Correspondent.)

Ironworks Resume Operations.

THE general trade position in the North of England continues to improve, and productive plant which has been idle for some considerable time is gradually being put into operation once more. It is true that progress in this direction proceeds slowly, but there is every appearance of the process of restarting idle plant being speeded up if conditions continue to improve as they are doing. The Carlton Ironworks of Dorman, Long and Co., Limited, which were closed down three months ago, have been restarted this week, a blast-furnace having been put into operation on the production of ferro-manganese. This brings the total number of blast-furnaces in operation on the North-East Coast up to forty, and it is hoped in the near future that that number will be further increased.

Cleveland Iron Trade.

The Cleveland pig iron market has settled down to a period of quiet but steady trade. With the turn of the year so near, consumers are not keen to commit themselves, and the promise of a bigger export demand, founded upon a rise in continental producers' quotations, has not been fulfilled. Apparently prices on the Continent have fallen again, and although there is still a limited market for Cleveland iron of good quality, the prices are too high to ensure the hoped-for expansion of overseas trade. A certain amount of special foundry iron has been sold this week to the United States, and there seems hope of further sales. But here, again, prices and transport charges shut out ordinary brands of foundry and hematite iron from the American market. However, the home trade is still healthy, shipments to European ports are well maintained, and sales are on such a scale as seem to warrant some increase in the number of furnaces operating. In fact, some of the makers are so well sold that they have little or no iron to offer for delivery to the end of the year. Prices are firm and unchanged, No. 1 being 87s., No. 3 82s., No. 4 foundry 81s., and No. 4 forge 80s.

Hematite Pig Iron.

A fair amount of business continues to be transacted in the East Coast hematite pig iron trade, and makers' stocks are being rapidly reduced. Mixed numbers are quoted at 88s. 6d., and No. 1 at 89s.

Ironmaking Materials.

Interest in the foreign ore trade seems to have fallen away again, but sellers adhere firmly to 22s. 6d. per ton as the quotation for best Rubio ore c.i.f. Tees. Nor has the weakness in the export market for coke in any way affected the home price, Durham makers still quoting 25s. per ton for good furnace brands delivered at the works.

Manufactured Iron and Steel.

A much more hopeful feeling is noticeable in the manufactured iron and steel trade. Inquiries generally are larger and more numerous, and a good few contracts for delivery over periods next year have been arranged. The placing of orders for ships has reacted on the demand for shipbuilding requisites, and orders for railway and constructional material are reported. There is a particularly active demand for corrugated sheets. India, South Africa, South America and Scandinavia are all buying, and the works are booked for months ahead. The price of 24 gauge now ranges from £17 10s. to £18. Sales of black sheets, on the other hand, are very slow, and supplies can be bought at as low as £12.

The Coal Trade.

The Northern coal trade exhibits a brighter appearance, and the tone generally is somewhat firmer. Operators take a very hopeful view of the outlook. There are numerous inquiries indicating a better demand in all directions. There seems to be a growing tendency to place orders for next year, and although collieries are not operating at anything like present figures, there have been merchant transactions for considerable quantities for the turn of the year. During the week, several merchant contracts for parcels ranging from 20,000 to 30,000 tons have been arranged at prices around 19s. f.o.b., for best Northumberland steams. Offers from the Continent are much more numerous, and consumers are indicating higher prices, anything from 3d. to 4d. per ton higher than they have recently been indicating. At these prices, however, sellers decline to operate, except for immediate deliveries, and for next year are holding for higher figures. For the rest of the year the general position is fairly good. No more collieries have been laid off, and those that are working state that the output is being taken up steadily. In some cases where the colliery is booked, the buyers find it difficult to attract tonnage, but in many other instances the collieries are well supplied with boats. It is stated that a goodly amount of speculative buying is being recorded in steam coals, and more interest is being taken in Durham gas fuels, and coking unscreened is coming in for a good deal of attention. There is no expansion in the demand for coke, and production is more than ample to meet requirements. All descriptions are pressed on the market at late prices.

SCOTLAND.

(From our own Correspondent.)

Position Unchanged.

The industrial situation remains unaltered so far. The hopeful feeling apparent during the past week or two still permeates the various markets, but producers in general continue to await the expansion in business so urgently required. General opinion on 'Change does not favour the possibility of any improvement until after the turn of the year at the earliest. There have been movements that might be taken to indicate increased activities in certain directions, but it is considered more than likely that such inquiries are more in the nature of a test of markets than immediate intention to buy. There is still too great a contrast between the prices quoted for home and competitive imported material to leave much margin of hope to local producers, and in this respect a continuance of the reported upward movement of continental quotations would brighten the outlook considerably. Meanwhile, only in specified home materials can local producers hope to have a sound chance of gaining contracts. Prices remain unchanged with few exceptions, but a particularly good order might receive favourable treatment in the matter of costs.

Pig Iron: More Inquiry.

The pig iron market has shown more signs of life of late, inquiries on home account being more frequent. A slightly better turnover is reported, but prices are practically stationary, as makers are anxious to effect a decrease in stocks which have accumulated to a considerable extent during the quiet period. Export inquiries remain weak.

Steel and Iron.

On the whole, the scarcity of new specifications is still pronounced. Some consumers have covered their requirements for certain materials over the next few months, but a more general anticipation is required to make any pronounced improvement in markets all round. Reports of better employment at some shipyards have engendered a more confident feeling, but the question of prices may be the deciding factor against home products. Meanwhile, steel plates and sections make small progress, and in some cases mills are only kept going under great difficulty. Steel sheets of the thinner varieties are busy, and inquiries are on the increase again. Galvanised sheets are especially firm, and subject to an increase in price at any moment. The bar iron works remain short of tonnage, and the re-rolled steel branch of this industry is similarly placed. The latter can be bought round about £9 per ton for home or export delivery.

Coal.

Conditions in the coal trade are neither better nor worse than they were last week. Business during the past week has been most erratic, and there is no indication that the lowest levels have yet been touched. Collieries in all districts are on the outlook for fresh orders to replace contracts nearing completion, but their efforts in this direction are barely successful. Lanarkshire splints had a mild spurt during the week owing to some demand for shipment to West Italy, but all other descriptions of round fuel were very poorly supported. Lanarkshire washed materials, also, are weaker, and the same pertains in all districts. Single nuts may be excepted from this general statement by virtue of a better demand on home account. Lanarkshire ells, Fifeshire and Lothians steams are all weakening, business having been done on occasion somewhat below the prices quoted openly. Aggregate shipments amounted to 246,872 tons, against 264,251 tons in the preceding week and 305,298 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

There has been a slight improvement in the steam coal trade, but it cannot as yet be described as very appreciable. It applies more particularly only to a few grades of coal. Tonnage supplies have been very disappointing during the past few days. It was thought that the arrivals over last week-end would have strengthened the position of collieries, but there have again been vacant loading berths this week, which is a sure indication that some collieries are suffering from the want of empty wagons and are unable to secure the release of standing coals. Reports from the various districts of the coalfield show that whereas work has been resumed at some pits which recently have been idle, others have been compelled to stop operations, so that, on the whole, there is not a great deal of change from the point of view of employment. Fresh orders from abroad for prompt shipment continue to be slow, and the question of competition on the part of European and American coals is a matter of no little concern to all interested in the export trade. As a matter of fact, the Commercial Committee of the Coalowners' Association has been giving consideration to the subject. Representatives of this Committee had a meeting at the end of last week with representatives of the exporters, when the latter confirmed the information which the coalowners had received that lower prices of foreign coals were having a prejudicial effect upon the South Wales export trade. The upshot of the conference was that a sub-committee, consisting of coalowners and exporters, was appointed further to investigate the whole matter. As regards contract operations over next year nothing further of note has been revealed, but it is believed that the British Admiralty's purchase does not exceed more than between 300,000 tons and 400,000 tons for delivery over the whole of next year. The French State Railways are in the market for the supply of 5000 to 10,000 tons of large coal per month for delivery over the first three or six months of 1925, and the Algerian State Railways are inquiring for round about 55,000 tons of patent fuel for shipment during the first half of next year.

Tin-plate Trade.

It is something new to hear doleful reports concerning the state of the tin-plate industry, but from all accounts the industry is passing through a depressing period, which manufacturers seem convinced is only temporary. They hold the view that they are fully able to maintain their own in all their old markets, and that the depression now existing, while brought about through a variety of causes, is principally due to the world-wide depression which obtains. The effect upon various works is, however, very unpleasant. In the early part of this week three works, employing about 1400 men in the Swansea district, were entirely idle, and the same was the case with four works in the Llanelly area, which affected about 1000 men. Apart from these establishments, there are fourteen works which are on short time, and they are stopping work in rotation for a week at a time while the depression lasts. A continuance of the slump will, of course, have a detrimental influence on the steel trade, and, as a matter of fact, some works are already working into stock, owing to the lack of orders. One interesting item of news regarding the tin-plate trade is the move which has been made by Mr. Percy Player, of the tin-plate firm of John Player and Son, of Clydach, respecting the superannuation of workmen. Some time ago the workmen's side put forward a request at a meeting of the Joint Industrial Council that a superannuation scheme should be formulated. Mr. Player has now proposed a scheme for the workers for his firm. Subject to the approval of the latter, the firm will contribute £10,000 as a nucleus, and the workmen will contribute a small sum weekly. Superannuation is suggested for millmen at the age of fifty-five, tin-housemen at sixty, and foundrymen, &c., at sixty-five.

Steel Bars.

The South Wales Siemens Steel Association has decided to reduce the price of bars. Tin-plate bars are brought down from £8 12s. 6d. to £8 7s. 6d. per ton, less 7s. 6d. per ton rebate, to the tin works in the stabilisation (prices) scheme, and sheet bars are reduced from £8 5s. per ton net delivered locally to £8 net, and from £8 0s. 3d. per ton to £7 15s. 3d. net delivered South Wales and Monmouthshire. It is reported that no alteration is to be made in the price of tin-plates.

Engineering Exhibition.

The annual exhibition of engineering plant, organised by the South Wales Institute of Engineers, opened on Thursday of this week at the Drill Hall, Cardiff, and will continue open up to Saturday night of next week. This Exhibition has quite established a reputation throughout the country, and increases, not only in popularity, but in the size of the undertaking every year. On this occasion, although use is being made of a recently erected extension, the space is quite insufficient to accommodate the products of the firms which have made application, which in itself is evidence of the value of the Exhibition. The present collection of exhibits eclipses all previous shows for the variety and up-to-dateness of the appliances. There was a general meeting of the Institute and of engineering firms and their representatives on Thursday, when the Lord Mayor (Alderman W. H. Pethybridge) delivered a speech of welcome, and later the Exhibition was formally opened by Mr. W. A. Chamen, the President of the Institute. The promoters have arranged an interesting programme of events, and apart from the proceedings, at which papers will be read, the social side has not been neglected, so that what has come to be known as "Exhibition Week" should be educationally valuable and enjoyable to all who are interested and are able to attend. The Executive Committee and the officers have done their work well in the matter of organisation.

Current Business.

There has been a shade better inquiry for coals this week, though most buyers have preferred to delay effecting their purchases until their tonnage is in dock, when many of them have been able to obtain their requirements on relatively better terms by assisting some of the colliery undertakings to clear wagons. The demand for bituminous and dry duff coals has materially improved, and prices are better, while superior bunker smalls have been fairly firm, but otherwise there has not been any appreciable change. Anthracite coals retain their firmness. Pitwood is a shade more plentiful, and not quite so firm.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are informed that the business of Messrs. Coode, Fitzmaurice, Wilson and Mitchell, consulting engineers, of 9, Victoria-street, Westminster, S.W. 1, will be conducted by the surviving partners without any alteration of the title of the firm.

We are informed that the ownership of the Cooper Roller Bearings Company, of King's Lynn, has recently changed, and that the new proprietors have appointed Mr. C. A. Ablett, M. Inst. C.E., as managing director. Mr. Ablett is also the managing director of the Unbreakable Pulley and Millgearing Company, Limited, of Manchester.

Radio Instruments, Limited, of 12, Hyde-street, New Oxford-street, W.C. 1, desires us to announce that the Northern Radio Company, Limited, of 19, Hopwood-avenue, Manchester, no longer holds its agency for the northern district, and that neither that company nor anyone else has authority to represent it in any way. Until such time as new agents be appointed, it is requested that all communications should be sent direct to Radio Instruments, Limited, at the address given.

CONTRACTS.

Vickers Limited, of Barrow-in-Furness, has supplied the six 15-ton electric capstans which are now being got into position for manœuvring vessels into and out of the large graving dock which is now nearing completion at Durban and will be opened next March.

Hartley, Sons and Co., of Stoke-on-Trent, have received a further order from the Leeds Corporation for six acres of their patented power-driven rectangular wind balanced sewage distributors. This addition will make eighteen acres of distributors that this firm will have installed for the Leeds Corporation.

The High Commissioner for the Union of South Africa has placed an order on behalf of the South African Railways Administration with the Leeds Forge Company, Limited, of Leeds, for the supply of a pair of coach underframes and bogies specially designed on the articulated principle. The bodies will be built in South Africa. These coaches are intended for the use of the Governor-General and in the first instance will be employed in connection with the forthcoming visit of H.R.H. the Prince of Wales to South Africa.

The Lyons Fair.—The next Lyons Fair will be held from March 2nd to the 15th, 1925, and will contain exhibits from upwards of twenty different countries, especially those of the manufacturing countries of Western Europe. The Fair was attended by over 3000 exhibitors this year, and it is expected that this number will be exceeded in 1925. For the forthcoming Fair an advanced edition of the official catalogue, embracing about 90 per cent. of the total exhibitors for 1925, is being published. This catalogue has been completely translated into English, and a supply will be available in a few days.

Cast Iron Research Association.—In the unavoidable absence of Lord Weir, Mr. H. B. Weeks presided at the third annual meeting of the Cast Iron Research Association in London on November 19th. The Chairman laid stress on the great progress made during the year, and summarised the main developments, particularly the extended research programme and the establishment of a laboratory. The report and accounts were adopted, these showing a considerable improvement. Sir John Dewrance, K.B.E., was elected president of the Association for the period 1924–26.

The James Watt Dinner.—On Friday last the annual James Watt dinner of the Institution of Engineers and Shipbuilders in Scotland took place at the Grosvenor Restaurant, Glasgow. The company was a large one, numbering, including guests, about 330 persons. Mr. J. Howden Hume, the president of the Institution, was in the chair, and after the loyal toasts had been honoured the toast of "The City of Edinburgh and the City of Glasgow" was proposed by Sheriff A. O. M. MacKenzie, K.C., and replied to by Lord Provost Sir W. L. Sleigh, of Edinburgh, and Lord Provost M. W. Montgomery, of Glasgow. "The Memory of James Watt" was pledged in silence, after which the toast of "Our Guests" was proposed by Sir Hugh Reid and replied to by Sir Thomas Paxton. A pleasing feature of the evening was the excellent programme of music, which was given by members of the British National Opera Company. The arrangements for the dinner were ably carried out by Mr. Edward H. Parker, the secretary of the Institution.

Heat Engine and Boiler Trials.—On Thursday, December 11th, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1, there will be a joint meeting of that body with the following:—The Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, and the British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat Engine and Boiler Trials. The following subject, introduced by the chairman of the Committee, Captain H. Riall Sankey, C.B., C.B.E., will be submitted for discussion, "Standards of Comparison in Connection with the Thermal Efficiency of Steam Engines." Mr. Basil Mott, C.B., President, Institution of Civil Engineers, will take the chair.

Forthcoming Exhibition at Grenoble.—The Department of Overseas Trade has recently received particulars of an Exhibition of Hydraulic Power and Touring, which is to be held at Grenoble from May to October next year. The exhibition, which will be held under the official patronage of the French Government, will be organised by the municipality and Chamber of Commerce, and have the support of the interested Ministries. Its general aim will be the advertisement of progress made during recent years in the use of hydraulic power, not only in the production and distribution of electricity, but in its adaptation to the needs of modern domestic life and transport. The exhibition grounds, which will cover 50 acres, are within a few minutes of the centre of the town. United Kingdom firms will be able to exhibit in the general buildings, which may be briefly classified as devoted to (*a*) the production of power; (*b*) the application of power; (*c*) touring (including sports); and (*d*) transportation. The charges for space in the buildings range from 100f. per square metre of wall space to 350f. per square metre (superficial) for special sites. Sites in the open vary from 250f. to 350f. per square metre according to the purpose of the exhibit, with a reduction of cost for areas exceeding 20 square metres. Copies of the general syllabus may be had on application to the Exhibition and Fairs Division, Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 15 0	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 8 6	4 8 6
No. 1	4 9 0	4 9 0
Cleveland—		
No. 1	4 7 0	4 7 0
Silicious Iron	4 7 0	4 7 0
No. 3 G.M.B.	4 2 0	4 2 0
No. 4 Foundry	4 1 0	4 1 0
No. 4 Forge	4 0 0	4 0 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 5 0	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 0	
„ Forge	3 10 0 to 3 12 0	
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 17 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 5 0 (a) / 5 10 0 (b)	—

MANUFACTURED IRON.

	Home. £ s. d	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. Coast—		
Common Bars	12 0 0	—
Lancs—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	12 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ¼in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¼in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 0 0†	—
Light „	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 10 0	
„ (others)	9 15 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	—
„ (Lancs. Boiler)	13 0 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0	—
Hoops	12 10 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	9 5 0 to 10 0 0	
Billets and Sheet-bars	7 10 0 to 7 15 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 10 0 to 17 12 6	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	255 5 0
„ (three months)	258 5 0
Copper (cash)	63 10 0
„ (three months)	64 12 6
Spanish Lead (cash)	40 0 0
„ (three months)	37 2 6
Spelter (cash)	34 17 6
„ (three months)	34 15 0
Manchester—	
Copper, Best Selected Ingots	69 10 0
„ Electrolytic	70 10 0
„ Strong Sheets	94 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	43 0 0
„ Foreign	41 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
„ 6 p.c. to 8 p.c. „	£23 10 0	7/9
„ 8 p.c. to 10 p.c. „	£23 0 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£43 0 0	16/-
„ „ 1 p.c. „	£52 0 0	17/6
„ „ 0.75 p.c. carbon	£60 0 0	20/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£17 17 6 scale 6/- per unit	
„ Vanadium	18/3 per lb.	
„ Molybdenum	7/9 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£155	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	16/9
„ „ Ell	18/6
„ „ Splint	19/- to 22/-
„ „ Trebles	19/9
„ „ Doubles	19/-
„ „ Singles	13/3
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
„ „ Splint	19/-
„ „ Trebles	19/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	15/- to 17/1
Screened Navigation	24/6
Trebles	21/6 to 22/-
Doubles	19/-
Singles	13/9
Lothians—	
(f.o.b. Leith)—Best Steam	16/3
Secondary Steam	15/6
Trebles	20/-
Doubles	19/-
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	28/6
Household	45/- to 58/4
Coke	30/-
Northumberland—	
Best Steams	18/6
Second Steams	17/6 to 18/-
Steam Smalls	10/9 to 11/-
Unscreened	15/6 to 17/-
Household	23/6 to 25/-
Durham—	
Best Gas	21/-
Second	17/3 to 18/-
Household	23/6 to 25/-
Foundry Coke	23/-
Sheffield—	Inland.
Best Hand-packed Branch	32/- to 35/- —
Barnsley Best Silkstone	26/- to 28/- —
Derbyshire Best Brights	27/- to 32/- —
„ „ House	24/- to 26/- —
„ „ Large Nuts	22/6 to 25/- —
„ „ Small „	14/- to 16/- —
Yorkshire Hards	20/6 to 23/- —
Derbyshire „	20/6 to 22/6 —
Rough Slacks	9/6 to 12/- —
Nutty „	9/- to 11/- —
Smalls	5/- to 7/6 —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 21/6 to 22/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/- to 27/6
Second „ „	25/6 to 26/6
Best Dry Large	27/- to 27/6
Ordinary Dry Large	24/- to 26/-
Best Black Vein Large	24/- to 24/6
Western Valley „	23/6 to 24/-
Best Eastern Valley Large	23/- to 24/-
Ordinary „ „	22/6 to 23/-
Best Steam Smalls	16/- to 18/-
Ordinary „	13/- to 15/-
Washed Nuts	22/- to 32/-
No. 3 Rhondda Large	27/- to 27/6
„ „ Smalls	19/- to 20/-
No. 2 „ Large	22/6 to 23/6
„ „ Through	18/- to 20/-
„ „ Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/6 to 27/6
Pitwood (ex ship)	29/- to 29/6
Swansea—	
Anthracite Coals	
Best Big Vein Large	47/6 to 50/-
Seconds	40/- to 45/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	59/- to 60/-
Nuts	55/- to 60/-
Beans	42/6 to 45/-
Peas	19/- to 23/-
Breaker Duff	9/6 to 10/-
Rubbly Culm	12/- to 12/6
Steam Coals:	
Large	22/6 to 23/6
Seconds	22/- to 22/6
Smalls	14/- to 16/-
Cargo Through	17/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast furnaces only, 16/9, with fluctuations according to analysis; open market, round about 22/6 to 25/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Import Duties.

THE Government will soon be introducing the new Bill for adjusting the import duties to the altered conditions of trade, and more especially for enabling it to negotiate with other countries for the treaties of commerce which will necessarily have to be carried through now that Germany is on the point of recovering her economic independence. The main lines of the new tariff were drawn up about two years ago, and the details have undergone frequent changes as the result of recommendations from different branches of trade and industry. In a general way, the tariffs show appreciable increases, except as regards necessaries, textiles and certain other products. The increases are due principally to the creation of a new classification, which will be much more elaborate than the existing one, and many manufactured goods that are at present included in a category to which a lower tariff is applied will be placed in a new category with a higher rate. At the same time, it is intended to fix the duties on a gold basis, which will, of itself, mean an appreciable augmentation, and it will probably be found that so far as goods entering into competition with French productions are concerned the increase will be considerable. The Bill, however, will be very elastic in character, in the sense that while the minimum is increased, a great latitude will be allowed for the application of maximum and intermediate tariffs. This is intended to provide a means of bargaining for concessions from other countries, and at the same time to afford adequate protection for home industries.

Paris Water Supply.

If the present rate of increase in the water consumption should continue, it is estimated that in ten years' time Paris will be requiring an average of a million and a-half cubic metres a day. The consumption is now 440,000 cubic metres. It is true that the augmentation in consumption during the past few years has been abnormal on account of the phenomenal increase of population, but it can hardly be assumed that the progression will be maintained in the future. Nevertheless, the Municipal Council considers it wise to take this progression into account, and to adopt such measures as may be necessary to ensure adequate supplies. For the moment, the daily supply available consists of 300,000 cubic metres of spring water and 300,000 cubic metres of filtered and sterilised water from the Seine and the Marne. In three years' time there will be added a further 250,000 cubic metres, made up of spring water from the Dragon and Fontaine-sous-Jouy, and water from the new filtering beds at Ivry. As no more supplies of spring water appear to be available, the only hope of keeping pace with the increasing requirements is to adopt one or other of the vast projects that have been under discussion for a considerable time past. The subterranean water in the Vals de Loire would provide Paris with a million cubic metres a day, but so far the idea of tapping this water has been strongly resented by the local populations, who fear that it will have the effect of reducing the already low level of the river Loire. The other scheme is the construction of reservoirs on the upper reaches of the Seine. The Prefect of the Seine declares that these schemes are being investigated, and that in a year's time a final decision will be come to as to which of the proposals should be carried through.

Monorail Cars.

A few years ago experiments were carried out with a new system of overhead monorail cars with propellers, and although little has been heard of them since that time, it would appear that the results were fairly conclusive, for the Commission d'Etudes of the Conseil Général de la Seine has reported in favour of a line being constructed between St. Denis and the Porte de la Chapelle in Paris. The granting of the concession now depends upon the decision of the Conseil Général. The length of the line will be 3.38 kiloms., and it will consist of twenty-two standards or piers, 150 m. apart, from which the rail or cable will be suspended at a height of 14 m. from the ground. The car will be constructed of duralumin, and will weigh 4 tons, without load. It will carry a maximum of a hundred passengers, and will be propelled by a reversible propeller having a diameter of 3 m. The theoretical speed is said to be 250 kiloms. an hour, but the operating speed will not exceed 80 kiloms.

Flood Protection.

The carrying out of works to protect Paris and the suburbs from inundations has been actively pursued for some time past, but they have been limited mainly to the raising of embankments, the demolition of the Monnaie barrage, and certain other operations of less importance, and a large amount of money has been spent upon preliminary investigation of the proposals to deepen the Seine and to construct an overflow canal to the north of Paris from the Marne to the Seine. The latter proposal is meeting with some opposition, because it would be very costly and would have no commercial value. So far nothing has been done with the big undertakings, which, however, it is hoped to put in hand at an early date. The Prefect of the Seine states that he will soon present projects for works which will cost 120 million francs, and which will include the construction of three reservoirs in the Morvan and in Champagne for regulating the level of the Seine, the deepening of the river below Paris and the execution of local works. In view of the recent decision of the Paris Chamber of Commerce that it is undesirable to spend money upon deepening the Seine, which, it declares, would offer no commercial advantage, it is probable that the proposal will meet with a good deal of opposition, and it is interesting to learn that the Conseil Général approves of the Chabal system of constructing reservoirs, before even the State and municipal engineers have been able to settle amongst themselves whether their construction is justified.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

223,514. May 20th, 1924.—FUEL INJECTORS, Swan, Hunter and Wigham Richardson, Limited, Walker, Newcastle-on-Tyne; F. Rowntree, 3, King's-road, Monkseaton; and P. Belyavin, 13, Otterburn-terrace, Jesmond, Newcastle-on-Tyne.

In order to avoid the disadvantages of the usual type of mechanically operated injector, the inventors employ a fuel injector of open type, in which the fuel is supplied through a hollow central plug passing through the injector body with a

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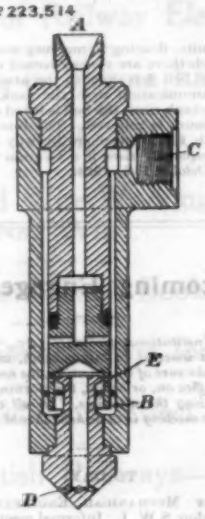

small annular clearance all round, into which the injection air is admitted, and a stationary pocket is provided in which the fuel collects and from which it is blown out by the spraying air. In the illustration the fuel is supplied by the passage A and collects in the pocket B. Air is supplied at C and forces the oil out of the pocket through the spraying jet D. On the way the oil is atomised by jets of air passing through the fine holes E.—*October 23rd*, 1924.

TURBINE MACHINERY.

219,655. June 6th, 1924.—A ROTOR FOR HIGH-SPEED ENGINES AND MACHINES, MORE PARTICULARLY STEAM AND GAS TURBINES, Aktiengesellschaft der Maschinenfabriken Escher Wyss et Cie., of Hardturmstrasse, 19, Zürich 5, Switzerland.

The turbine rotor described in this specification is formed so that the wheel disc is only very slightly larger than the diameter of the shaft. The turbine wheels are composed of a boss A and

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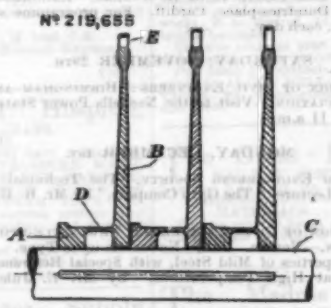

a disc-shaped wheel body B which carries the rotor blades E. The boss A is shrunk on and keyed fast to the shaft C. The boss A and the wheel disc B are connected to one another by a thin and yielding ring D, which is integral with the parts A and B. The wheel disc B is consequently overhung relatively to the boss A, and is therefore free to expand independently of the boss A, so that dangerous stresses do not occur in the rotor.—*October 9th*, 1924.

DYNAMOS AND MOTORS.

223,509. February 6th, 1924.—IMPROVEMENTS IN OR RELATING TO INDUCTION MOTORS, Dr. Tivadar Torda, of 28, Ujeguten, Budapest, Hungary.

This specification describes an arrangement for compensating the phase displacement of induction motors. In the diagram, S is the stationary primary winding, and R the rotary winding, which is connected through slip rings, and brushes in the starting resistance H, the short-circuiting contacts for which are shown at M. C is the winding for a frequency converter. This is rigidly coupled to the rotor R or alternatively it may form an integral part of it. Through tappings D current at a higher frequency than the slip-ring frequency can be fed into the winding C. For this purpose a rotating transformer T is provided. The three-phase secondary winding U of this transformer rotates with the frequency converter winding C, and is connected to the tappings D. The primary winding E of the rotating transformer is stationary. The action of the arrangement is fully described. Briefly, it is possible without increasing the number of slip rings to conduct currents at the slip frequency determined by the commutator brushes of the converter to the rotor acting as a secondary, and to feed currents of higher frequency into the frequency converter winding.—*October 23rd*, 1924.

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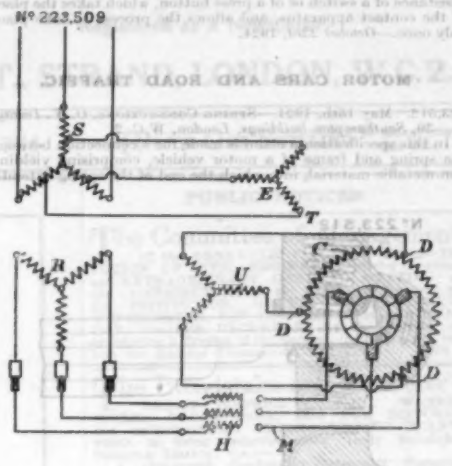

TRANSMISSION OF POWER.

223,511. August 3rd, 1923.—IMPROVEMENTS IN AND CONNECTED WITH ELECTRIC CABLES, The British Insulated and Helsby Cables, Limited, and John Lewis Parker, both of Prescot, and Charles Vernier, of 59, Church-road, Gosforth, Northumberland.

A cable constructed in accordance with this invention is shown in the accompanying illustration. A is the exterior lead or similar metal sheathing of the cable, which, in the case shown,

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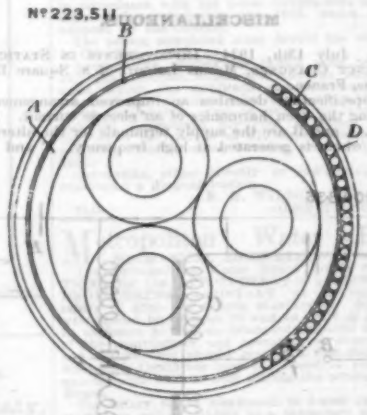

may be a three-core cable; B is a bedding of nearly incompressible material; C the reinforcing inner wires extending round it helically as usual; and D is a helical reinforcing winding of metal strip or tape, which bears upon and holds the reinforcing or armouring wires C, and the edges of the adjacent convolutions, which have a minimum amount of space between them.—*October 23rd*, 1924.

MEASURING AND TESTING INSTRUMENTS.

223,368. September 10th, 1923.—IMPROVEMENTS IN OR RELATING TO OBSERVING AND RECORDING CHANGES IN ELECTRIC CURRENTS AND IN MAGNETIC FIELDS, G. Gmür et Cie. and Gottlieb Gmür, both of Aarau, Switzerland.

This specification describes a process for observing and recording the time course of an electric current or pressure or a magnetic field by means of a cathode ray tube, in which the cathode rays are simultaneously exposed to the action of two fields at a co-ordinate angle to each other. A current from a source G of continuous current flows through a rotating contact apparatus S, the object of which is merely to connect or disconnect or to effect a short circuit through the electro-magnet M. The

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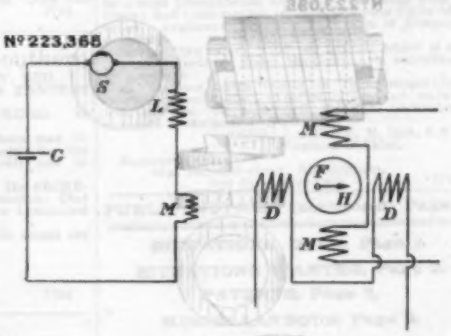


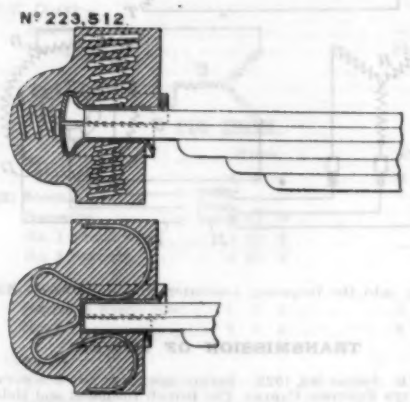
circuit contains practically no resistance, but it has a high inductance L. The field of the magnet M exercises a deflecting action on the cathode ray speck F, and deflects it transversely of the field direction, whilst the field to be investigated is generated by the magnet D. Each time that the contact device S closes the circuit of the source of continuous current G, the spot F begins to move at uniform speed in the direction H. It is possible to determine at will this uniform speed as well as the maximum distance of the spot from its zero position by suitably dimensioning the inductance and by choosing the tension and the duration of contact. It is merely necessary that the interruption should always take place considerably before the limit of current increase is reached. Obviously, the rotating contact

can be placed, if desired, directly on the machine to be investigated. In that way perfectly steady current or tension curves are obtained on the lighting plate of the tube. Instantaneous records can be very simply obtained with this device with the assistance of a switch or of a press button, which takes the place of the contact apparatus, and allows the process to take place only once.—*October* 23*rd*, 1924.

MOTOR CARS AND ROAD TRAFFIC.

223,512. May 15th, 1924.—Spring Connections, *O. Y. Imray*, 30, *Southampton-buildings, London, W.C.* 2.

In this specification a claim is made for a connection between the spring and frame of a motor vehicle, comprising yielding non-metallic material, into which the end of the spring extends,

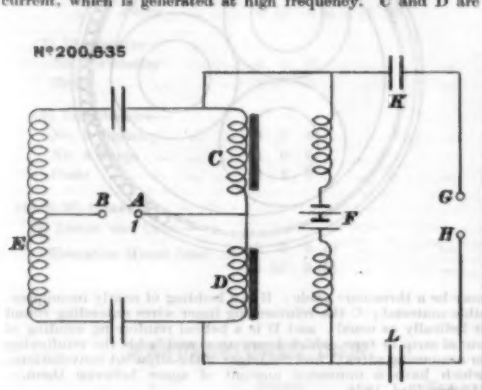


and having resilient reinforcing members moulded therewithin at pre-determined points to resist resultant major stresses impressed on the material by the spring and frame. The illustration shows two of several alternative arrangements given in the specification.—*October* 23*rd*, 1924.

MISCELLANEOUS.

200,835. July 13th, 1924.—Improvements in Static Frequency Changers, Marius Latour, of 8, Square Desaix, Paris, France.

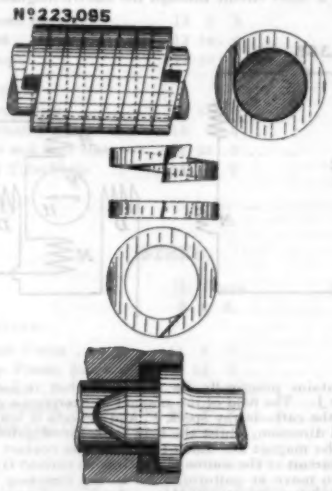
This specification describes an improved arrangement for developing the even harmonics of an electric current. In the drawing, A and B are the supply terminals for the alternating current, which is generated at high frequency. C and D are



inductance coils. A reactance coil E is connected in shunt with the coils, the middle part being connected to the terminal B, whilst the other terminal A is connected to the junction part of the two coils C and D. The source of direct magnetising current is shown at F, and it may be protected with choking coils, as shown. The developed harmonic current is taken from the terminals G and H through blocking condensers K and L.—*October* 13*th*, 1924.

223,095. January 9th, 1924.—Making Flanged Tubes, *W. E. Evans*, 27, *Chancery-lane, London, W.C.* 2.

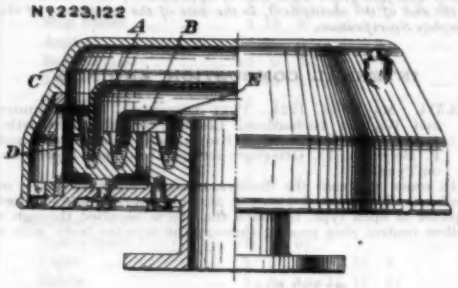
This system of making the collars or flanges for tubes is, according to the inventors, more expeditious and satisfactory



than the usual method of making each flange individually. A rod is wound to a helix of which the internal diameter corresponds with the external diameter of the tube. The helix is cut longitudinally and tangentially to form a series of collars. The tangential cut is adopted to provide a large area for welding. The collars are then welded on to the tubes by pressure, as shown in the lower drawing.—*October* 16*th*, 1924.

223,122. February 26th, 1924.—Relief Valves, T. A. Crompton, jun., and Blundell's London Copper and Brass Works (1910), Limited, West India Dock-road, Limehouse, London, E. 14.

This is a double-acting relief valve for fitting on oil tanks where it is necessary that the valve should open when the pressure in the tank rises above, or falls below, pre-determined maximum and minimum pressures. It comprises two bells



A and B, of vulcanite, floating in mercury seals and surrounded by a cap C in which there are vents covered with wire gauze D. The exterior of the bell A is open to the atmosphere, while the interior is in communication with the tank. Consequently, if the pressure in the tank rises, the bell is lifted out of the mercury seal, and the pressure is relieved. The interior of the bell B communicates with the atmosphere by way of the passage E, and the bell consequently rises if a vacuum forms in the tank and admits air.—*October* 16*th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. "Centrifugal and Rotary Pumps," by Mr. G. L. Ponsford. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Exhibition of latest scientific instruments and appliances for the use of engineers. 6.30 p.m.

Junior Institution of Engineers: Sheffield and District Local Section.—Rooms of Sheffield Metallurgical Association, 198, West-street, Sheffield. "The Aims and Operations of the Employment Exchange," by Mr. R. J. Stanley. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society, Newcastle-on-Tyne. Paper, "The Prediction of Critical Speeds in Ship Resistance," by Mr. J. Tutin. 7.30 p.m.

Royal Meteorological Society.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Joint meeting with the Physical Society. Discussion on "Ionisation in the Atmosphere, the Influence on the Propagation of Wireless Signals." 5 p.m.

TO-DAY AND TILL SATURDAY, DECEMBER 6TH.

South Wales Institute of Engineers.—Exhibition at the Drill Hall, Dumfries-place, Cardiff. For programme see page 591. 2 p.m. each day.

SATURDAY, NOVEMBER 29TH.

Institution of Civil Engineers: Birmingham and District Association.—Visit to the Nechells Power Station, Birmingham. 11 a.m.

MONDAY, DECEMBER 1ST.

Bradford Engineering Society.—The Technical College, Bradford. Lecture, "The Gyro Compass," by Mr. R. B. Pullin. 7.30 p.m.

Institution of Civil Engineers: Newcastle-upon-Tyne Association.—Neville Hall, Newcastle-upon-Tyne. Paper, "Some Properties of Mild Steel, with Special Reference to its Behaviour at High Temperatures," by Mr. E. Jule Rang. 7.30 p.m.

Institution of Electrical Engineers: Western Centre.—South Wales Institute of Engineers, Park-place, Cardiff. Paper, "Automatic and Semi-automatic Rectifier Sub-stations," by Mr. G. Rogers. 6 p.m.

Junior Institution of Engineers: North-Western Section.—Manchester Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. Lecture, "Modern Locomotive Lubrication Practice," by Mr. B. Spencer. 7.15 p.m.

Northampton Engineering College Engineering Society.—St. John-street, London, E.C. 1. "The Poulsen Arc," by Mr. E. E. Hutchings. 5.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. General monthly meeting. 5 p.m.

Society of Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Recent Developments in Ferro-concrete Cooling Towers," by Mr. H. A. Rickwood. 5.30 p.m.

TUESDAY, DECEMBER 2ND.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "Fire and Fire Protection," by Mr. R. B. Stewart. 6.30 p.m.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Paper, "Metal Spraying," by Mr. W. E. Ballard. 7 p.m.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Theatre, Armstrong College, Newcastle-upon-Tyne. Paper, "Aluminium, its Production and Uses," by Mr. G. B. Brook. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "Water Supplies to the Smaller Provincial Towns of Egypt," by Messrs. R. H. Lee Pennell and H. Addison. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Paper, "The Further Development of Large Power Diesel Engines," by Mr. W. D. McLaren. 7.30 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Papers, "Fuel Oil Resources of the Future," by Messrs. A. W. Nash and H. G. Shatwell; and "The Somerset Oil Shales," by Messrs. H. G. Shatwell, A. W. Nash, and J. Ivon Graham. 5.30 p.m.

West Yorkshire Metallurgical Society.—George Hotel, Huddersfield. Discussion on "The Corrosion of Engineering Materials." 7.30 p.m.

WEDNESDAY, DECEMBER 3RD.

Institution of Civil Engineers.—Students' visit to the Victoria Telephone Exchange.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Wireless Telegraph Valve Transmitters Employing Rectified Alternating Current," by Mr. G. Shearing. 6 p.m.

Institution of Municipal and County Engineers.—City Chambers, Glasgow. Scottish District meeting. 11 a.m.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, London, S.W. 1. Paper, "House Drainage, with Special Reference to the Intercepting Trap," by Mr. H. A. Roechling. 7.30 p.m.

University of London.—University College, Gower-street, London, W.C. 1. "High-frequency Electric Measurements. Lecture VI.: Electric Radiation," by Professor J. A. Fleming. 5 p.m.

THURSDAY, DECEMBER 4TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Lecture, "Gyroscopic Pendulums," by Professor J. G. Gray and Mr. J. Gray. 6 p.m.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Joint meeting with the Silver Trades' Society. Discussion on "Electro-plating." 7.30 p.m.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Accurate Gauge Work," by Mr. J. E. Sears. 5.30 p.m.

Junior Institution of Engineers: North-Western Section.—Visit to the works of Marine and Locomotive Superheaters, Limited, Mosley-road, Trafford Park, Manchester. 7 p.m.

Twentieth Century Society of London Graduates.—London School of Economics and Political Science, Kingsway, London, W.C. 2. Lecture, "The University of London—What it is and what it may be," by Sir Gregory Foster. 8.15 p.m.

FRIDAY, DECEMBER 5TH.

Institute of Transport.—Council Chamber, Town Hall, Leeds. Meeting to inaugurate Yorkshire Local Section. 6 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Extra general meeting. "The Effect of Low and High Temperatures on Materials," by Professor F. C. Lea; and "The Elastic Limit in Tension, its Influence on the Breakdown by Fatigue," by Mr. J. M. Lessells. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Metal Cutting under Water by the Oxy-acetylene Blow-pipe," by Mr. J. B. Pollard. 7.30 p.m.

SATURDAY, DECEMBER 6TH.

Institute of British Foundrymen: Birmingham Branch.—Chamber of Commerce, New-street, Birmingham. "Malleable Iron," by Mr. D. Wilkinson. 4 p.m.

MONDAY, DECEMBER 8TH.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Ships' Propellers," by Mr. S. E. Flack. 7.30 p.m.

Society of Engineers.—17, Victoria-street, London, S.W. 1. Annual general meeting. 6 p.m.

TUESDAY, DECEMBER 9TH.

Faraday Society.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Group of papers on "Base Exchange in Soils." 4.30 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "The Sliding Cylinder, Double-acting, Two-cycle Diesel Engine," by Mr. J. C. M. MacLagan. 6.30 p.m.

THURSDAY, DECEMBER 11TH.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85-88, The Minories, London E. 1. Joint meeting with the Institution of British Foundrymen. Paper, "Present Problems and Developments in Engineering Bronze Foundry Practice," by Mr. F. W. Rowe. 7.30 p.m.

FRIDAY, DECEMBER 12TH.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Discussion on "The Design of Furnaces for Annealing and Heat Treatment," to be opened by Mr. T. Hill. 7.15 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Fluid Transmission Gears," by Mr. H. G. Bonly. 7.30 p.m.

MONDAY, DECEMBER 15TH.

Junior Institution of Engineers: North-Western Section.—Demonstration Hall of Pathé Frères, 15, Deansgate, Manchester. Lecture, illustrated by film, "Fire Fighting, Ancient and Modern," by Mr. G. E. Taylor. 7.15 p.m.

Award of R. 38 Memorial Prize for 1924.—The Council of the Royal Aeronautical Society has decided that no paper submitted in 1924 for the R. 38 Memorial Prize is of sufficient merit to justify an award. In the circumstances, the Council has decided to award the prize for 1924 to Messrs. C. P. Burgess, J. C. Hunsaker, and S. Truscott, for their paper on "The Strength of Rigid Airships," which was submitted in 1923 and received special mention in that year.